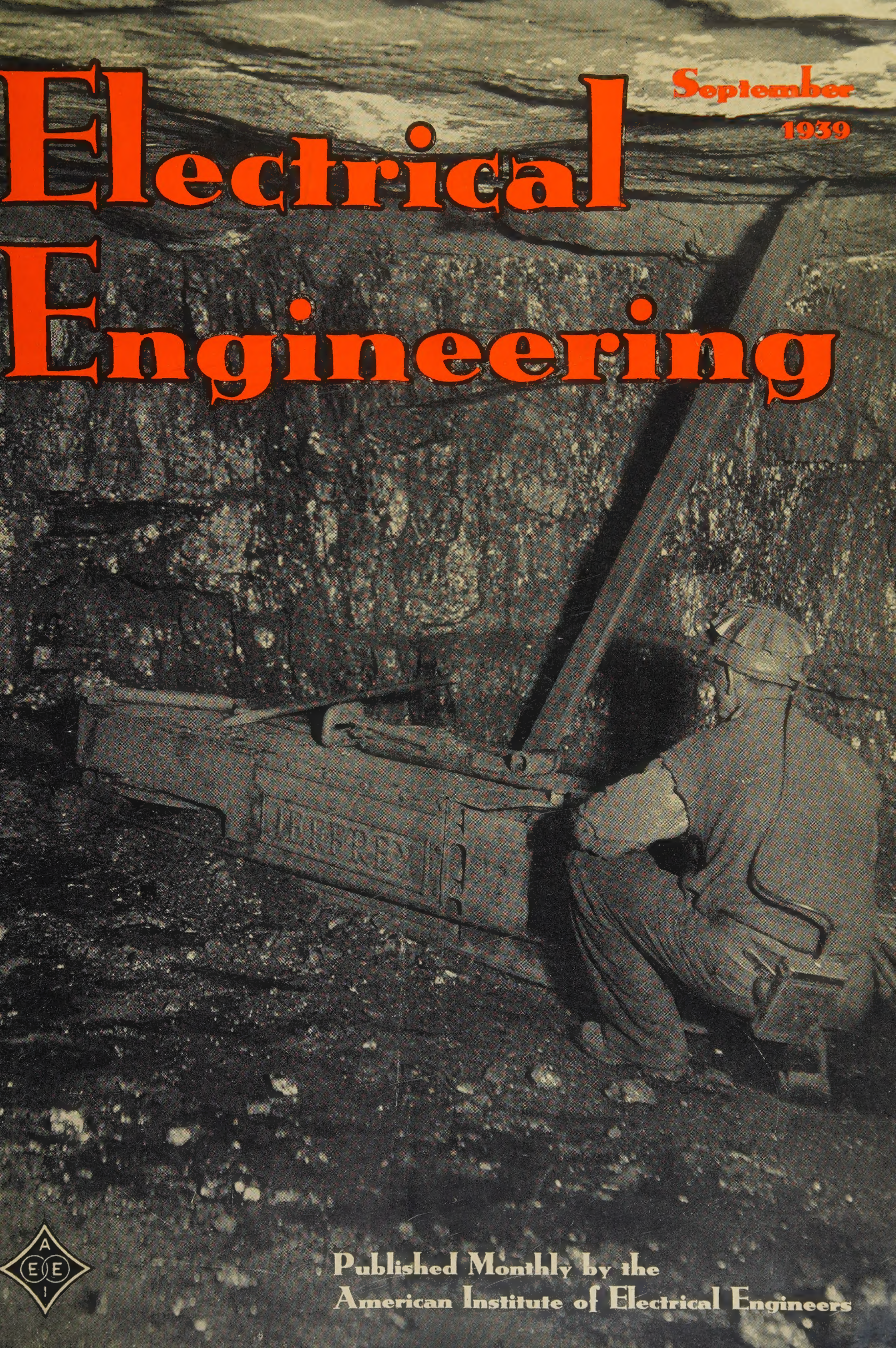
Electrical Engineering

September
1939



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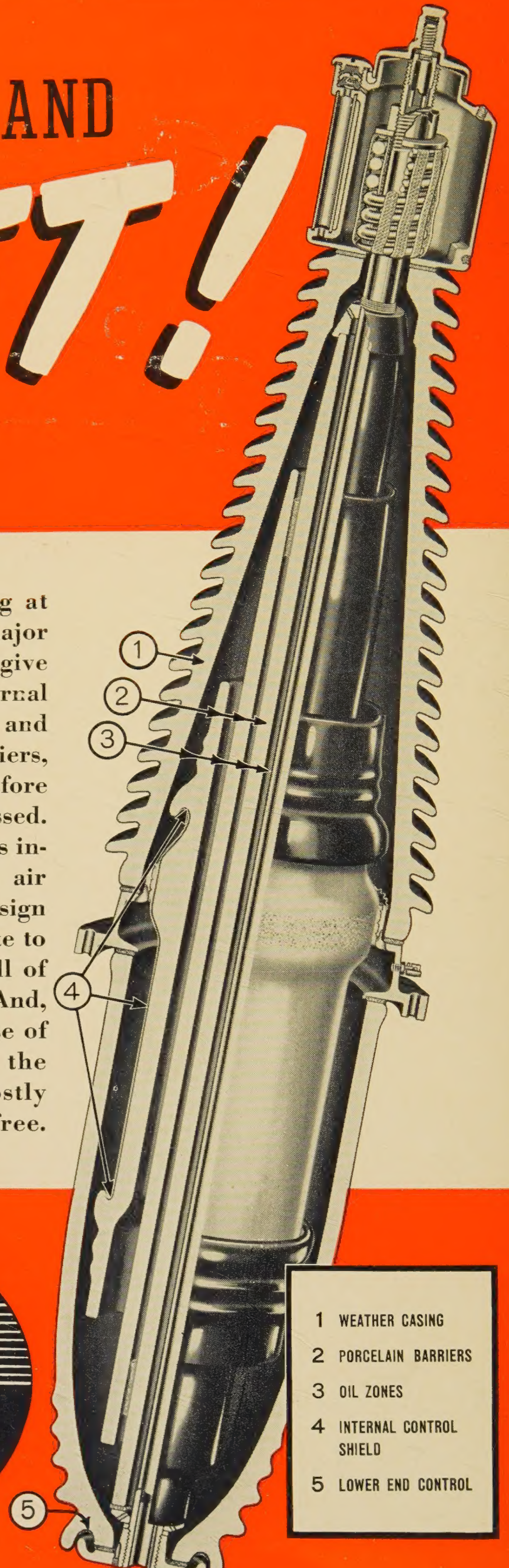
CARE-FREE . . . AND

QUIET!



● Why are O-B bushings non-radio interfering at voltages much higher than their ratings? The major reason is that they are graded and shielded to give correct stress distribution. Having a metal internal control shield with integral porcelain controls and using properly-shaped and placed porcelain barriers, O-B bushings would flash over on the outside before any part of the inside could become overstressed. The oil aids this feature by contacting inside parts intimately and by preventing corona-supporting air pockets. The upper porcelain weather casing design and external bottom grading shield also contribute to the quietness by eliminating external stresses. All of these features increase the electrical efficiency. And, with the compression assembly and the liberal use of a non-deteriorating insulation—porcelain—for the internal concentric barriers, they prevent costly troubles, making O-B bushings virtually care-free.

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Electrical Engineering

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for September 1939—

The Cover: Undercutting—the first application of electricity to the actual mining of anthracite coal. Various aspects of the use of electricity in this industry will be discussed at the AIEE Middle Eastern District meeting to be held at Scranton, Pa., October 11–13, 1939.

Transactions Section *(Follows EE page 404; a preprint of pages 435-98 of the 1939 volume)*

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(Founded 1884)

F. MALCOLM FARMER, President H. H. HENLINE, National Secretary

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High Lights

Temperature Rise. Measurement of temperature rise in induction motors is necessary to determine ratings, and AIEE standards recognize three methods: thermometer, resistance, and embedded detector. Some of the methods are not applicable to certain types of modern motors, and therefore recommendation is made that the resistance method be adopted as standard for partially or totally enclosed induction motors (*Transactions pages 459–67*). Because location of thermometers depends upon the judgment of the tester, extension of the use of the resistance method to all induction motors is urged, with the necessary revision of standard temperature ratings and conventional allowances for hot-spot temperatures (*Transactions pages 468–78*).

Rating of Motors. Both mechanical and thermal output limitations must be recognized in a system for rating of electric motors, any such system being arbitrary and dependent upon the service conditions. The increasing variety of motor uses and economic pressure have led to the use of overload capacity in small motors beyond the continuous ratings, and therefore a revision of American standards for general-purpose motors is proposed to enable the full economic life of motors to be utilized (*Transactions pages 445–59*).

Temperature Limits. Oil and cellulose insulation deteriorate rapidly when certain temperatures are exceeded, and hence set a limit to the ratings of electrical apparatus. Life tests now indicate that cellulose will undergo very little deterioration up to approximately 90 or 95 degrees centigrade in the absence of oxygen, and that ratings of apparatus from which oxygen is largely excluded may be higher than if free breathing were permitted (*Transactions pages 484–91*).

Social Responsibility. Declaring that it is "essential to the maintenance of a democratic society and to progress in solving baffling social problems to have the talents and active citizenship of engineers focused upon those problems," an engineering educator places upon the college the responsibility for developing habits, interests, and competences which will enable the engineer to co-operate with other citizens who are working toward the same ends (*pages 367–71*).

Middle Eastern District Meeting. Applications of electricity to mining will be discussed in a technical session, and a visit to an anthracite-coal mine is featured among inspection trips at the AIEE Middle Eastern District meeting, Scranton, Pa., October 11–13, for which four other technical sessions, a Student Branch convention, and a testimonial luncheon for Past-President Charles F. Scott (A'92, F'25, HM'29), are also scheduled (*pages 389–90*).

Human Relationships. At the general session of the recent AIEE combined summer and Pacific Coast convention a prominent power-company executive discussed some of the human relationships involved between management and workers, business and its customers, and business and government. He says that the critical developments of the past ten years are again bringing human values to the fore (*pages 371–3*).

AIEE Model Law. The draft of a model law for registration of engineers prepared by the AIEE special committee on model law and approved by the board of directors at its meeting in San Francisco, June 29, 1939, is published for consideration by AIEE members, together with a statement of the principles underlying the law and an introduction by the chairman of the special committee (*pages 374–9*).

Aging of Insulation. Organic insulating materials deteriorate progressively when maintained continuously at elevated temperatures. One result of a laboratory investigation of aging is substantiation of the reasonableness of 105 degrees centigrade as the maximum hot-spot temperature for purposes of standardization (*Transactions pages 435–44*).

Great Lakes District Meeting. Technical sessions on communication and research, electrical machinery and transportation, measurements, power transmission and distribution, are included in the program of the AIEE Great Lakes District meeting, Minneapolis, Minn., September 27–29, as well as a Student Branch convention, inspection trips, and entertainment (*pages 391–2*).

Magnet-Wire Insulation. Synthetic materials have come to occupy an important place in the insulation of electric conductors of all sizes, particularly magnet wire. A new synthetic-resin coating has properties that make it markedly superior to former enamel coatings (*pages 379–88*).

American Engineering Council. Among items appearing in the current AEC *Bulletin* are discussion of pending legislation for registration of engineers in the District of Columbia, and a survey of action taken at the last session of Congress for the improvement of patent procedure (*page 395*).

Past-President Scott to Be Honored. Among Institute activities commemorating the 75th birthday of Doctor Charles F. Scott (A'92, F'25, HM'29), will be a dinner meeting September 19, to be held by the Connecticut Section of which he was a founder and first chairman (*page 392*).

Voltage Correction. Choice of equipment for voltage correction on distribution circuits depends on the individual characteristics of the system, but the economic choice for one system may be representative for other similar systems (*Transactions pages 491–8*).

Motor Analogy. The problem of choosing a motor for a given duty cycle may be clarified by a hydraulic analogy that illustrates the relations between torque ability and temperature rise (*Transactions pages 478–83*).

Officers and Committees. Officers and committees chosen to serve the Institute during the year 1939–40 are listed in this issue. Listings of local Sections and Student Branches also are given (*pages 400–04*).

Coming Soon: Among special articles and technical papers now undergoing preparation for early publication are: an article on the nature, properties, and uses of polarized light, by L. W. Chubb (F'21); an article describing the Boulder-Chino 220-kv transmission line of the Southern California Edison Company, by Harold Michener (M'26); an article on a mechanical demonstrator of transmission-line surges by C. F. Wagner (M'27); an article on determination of optimum voltage for airplane electrical systems, by V. H. Grant (A'37) and M. F. Peters; a paper on the rating of electrical machinery and apparatus by R. E. Hellmund (F'13); a paper on loading transformers by copper temperature by H. V. Putman (M'32) and W. M. Dann (F'26); a paper discussing the effects of temperature on the mechanical performance of electrical machinery and apparatus by C. Lynn (A'38); a paper on the rating and application of motors for refrigeration and air conditioning by P. H. Rutherford (M'30); and papers on load ratings of cable by Herman Halperin (M'26) and maximum safe operating temperature for 15-kv paper-insulated cable by C. W. Franklin (M'24) and E. R. Thomas (M'30).

News 389

Subscriptions—$12 per year to United States, Mexico, Cuba, Porto Rico, Hawaii, Philippine Islands, Central and South America, Haiti, Spain, Spanish Colonies; $13 to Canada; $14 elsewhere. Single copy $1.50. ¶ Address changes must be received by the fifteenth of the month to be effective with the succeeding issue. Copies undelivered because of incorrect address cannot be replaced without charge. ¶ Electrical Engineering is indexed annually by the Institute, weekly and monthly by *Engineering Index*, and monthly by *Industrial Arts Index*; abstracted monthly by *Science Abstracts* (London).

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Social Responsibility of the Engineer

ROBERT E. DOHERTY
MEMBER AIEE

WHETHER engineers should assume a larger measure of social responsibility has been debated extensively during the last decade with practical results that are not impressive, yet there appears to be significant crystallization of professed opinion. While the view still lingers here and there that the engineer should stick to his technical knitting, letting other professional men worry about the social consequences of his work, there is nevertheless a pervasive and growing opinion that he should play a more active part in the social realm and that his educational preparation should take this aim into account. However, the extent of the discussion and of apparent agreement upon this point is out of all proportion to the practical results, as measured either by active participation or by changes in educational programs looking to participation. Progress seems to be stymied biologically; after professional maturity, we seem to exhibit a certain elasticity of professed view but tend nevertheless to cling tenaciously to established habits. Not having participated, we don't start. Thus as a profession of engineers and educators we seem to agree upon principle, and more or less let it go at that.

There is significant evidence of this attitude. While a few national engineering societies appear interested in social values that might come from united effort, others seem indifferent. Witness the precarious status of the American Engineering Council, which is withering from lack of support; yet it represents the only national medium through which the engineering profession as a whole can serve national welfare as well as its own interests. And it is my understanding that the Council has done a good job within its means. Another example is the Engineers' Council for Professional Development. This is the only organization that is constituted by proper representation to lift the engineering profession on all fronts to the level that it deserves and that we all wish for. And it has made measurable beginnings in four important directions, as presumably you all know. Yet the reservations with which some engineering societies enter it indicate a significant attitude of self-sufficiency. Naturally it is not for me to question in the least their full right to any attitude they wish to assume. I am merely citing it as evidence to my point that the engineering profession, although tending to agree that the engineer's station in society should be higher and his responsibility greater, has not yet reached the point of doing much about it. Neither has the teaching profession, as a glance at engineering curricula will indicate. A few show some revision toward the end of greater social and humane understanding but by and large the portion of the curriculum assigned to this end is distressingly meager. Status quo tends to persist.

Meantime national life proceeds more and more precariously. While we tire of hearing tales of woe, the ugly fact is that strife and confusion characterize the American scene. Pressure groups fight for selfish advantage; political demagogues try to outdo each other in leading raids upon the public treasury; labor fights with employers and with itself; and government and business are at loggerheads. Although Theodore Roosevelt invented the "square deal," Woodrow Wilson the "new freedom," Hoover the "new era," and Franklin Roosevelt the "new deal," nevertheless, after a generation of political discovery and invention, the American people have become more baffled than ever in their efforts to incorporate the vast discoveries and inventions of science into their scheme of living, so that they might realize in peaceful, prosperous, and happy lives the limitless potentialities of these intellectual and material achievements. Individuals, groups, classes, and nations quarrel over the division of limited production instead of co-operating to provide an abundance for all; and they wantonly squander existing values and mortgage those of the future. Youth is discouraged; business men are confounded; trustees of great endowments don't know what to do; men without funds and men without work don't know what to do; nobody knows what to do!

What is the outlook? One's optimism is, I realize, likely to be adversely conditioned by immediate circumstances such as these I have just mentioned. On the other hand, the mere exhibition of optimism unfortunately is not very fruitful in an analysis; and whistling in the dark will not stop the lurking gangster. So for the next few minutes at least I may appear to assume the role of the pessimist, for I must confess that within my limited view there is little promise of long-range social felicity unless I postulate some new element that is not yet manifest in the body politic.

History is not reassuring. In his article "Are Revolutions Necessary" historian Guy Stanton Ford, now president of the University of Minnesota, said this:

> "To the question 'Must short-time and long-time changes end always in conflict and violence?' the historian can only answer with certainty that the clash between beneficiaries of the existing order and exasperated advocates of change has always so ended. Each time, resistance to modest reform is blind to the wisdom of concession and the necessity of change. If concessions are made, they come too late. The demands have risen and the price of peace is again too high, only to become again too cheap. The reactionary breeds the radical among reformers, the approaching conflict falls under the leadership of these two opposing extremes, and the conflict follows. The process has been repeated so often in so many fields that it appears inevitable and, historically speaking, necessary.
>
> "Have we before us any hope that mankind has, after all these

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Address presented at the annual meeting of the Society for the Promotion of Engineering Education, State College, Pa., June 19–23, 1939.

ROBERT E. DOHERTY is president of Carnegie Institute of Technology, Pittsburgh, Pa., and has long been active in the AIEE, SPEE, and the Engineers' Council for Professional Development.

centuries, learned a way to make, without violent dislocation, the necessary readjustments in his relations to his material environment and his fellow man?"

To President Ford's answer that there may be hope if we can learn to be tolerant and maintain the sanctity of free press, free speech, and the scholar's immunity to pursue truth, I would add two other essentials: (1) that we learn to make practical use of a new power within our reach that the generations of history did not have—the power of reasonable prediction that may come from the scientific method if it be applied to social and economic problems with the same intelligence as it has been applied during the last few generations to physical problems; and (2) that in our democracy we find a way to accomplish widespread social interest and understanding among professional men. Tolerance is necessary, but understanding there must be also; the issues even in their simplest forms become too much for most untrained, uninformed minds. There must be here and there among the masses cultivated intellects that can understand and give support to informed decision. And there must be in the councils of the state and nation not merely professional expertness, but expertness fortified by broad social understanding and a willingness to co-operate.

I am clear that there is not a political panacea for our woes. Many feel that a less severe attitude by the national administration would be helpful, but I am confident that neither such an attitude nor a change of administration would solve the problem, because at bottom it is not political. It existed before the present administration came to office and will continue when a new administration comes to power. Social forces of the character and magnitude of those which now press us are not to be controlled by the fickle furor of partisan politics. Oscillating like a mighty, sweeping pendulum, they swing us back and forth with ever-increasing violence between glut and poverty. And it will take more than political oratory to deal with the situation.

The job of professional statesmanship is to see that an end be put to the political hand-to-mouth method of dealing with social problems, and that these be recognized and attacked early enough and intelligently enough so that people's minds may become *gradually* accustomed to the new ideas involved. Then perhaps necessary change may be effected without violence and chaos. It is my purpose during the next few minutes to outline how I think engineers should enter this situation: why they should assume greater social responsibility, what it might be, and how their active interest might be won.

The fundamental ground on which I believe engineers should assume greater social responsibility is the fact that, after all, we live in a democracy. I have found it difficult to elicit interest in this idea because there is a widespread inclination to regard allusions to democracy and competent citizenship as sentimental vapor—as something nice to talk about, especially on flag day, but not in serious meetings of the kind I take this to be. Such matters are left largely to primary and secondary schools. But I do hope we can set aside such insidious prejudices if we have them, because there is involved here a deeper significance than momentary patriotic fervor; a greater responsibility, especially for professional men, than merely voting, accepting majority rule, and understanding the machinery of government. Our question transcends these; it strikes at the heart of the matter. Lifted out of the welter of confusing elements, the question we must answer is whether in our thinking and planning in connection with the future of engineering and engineering education in this country we are ready sincerely to accept as a philosophical basis the principle of democracy. If we are not, then I recommend that we prepare our exit. If we are, then we are obliged, if we be rational, to accept the implications.

These are simple. If the people or their representatives are to settle questions of state and national concern, then certainly they must be competent to do so, or the whole system becomes a farce. Indeed it appears already to be approaching this. Issues have become too complex for the masses to understand; indeed they have become too complex for those whose business it is to understand and deal with them. By the very nature of the case, therefore, if we accept the theory of democracy we must accept also the proposition that there should be available to government at all its levels intelligent understanding and competence to deal with problems of statesmanship that have to be solved.

Such competence in a democracy cannot be confined to a capacity for balancing the relative advantages of different courses of action and approving that course which appears best; it must include as well competence in the use of present-day facilities for making these alternatives understandable to the voters by whom basic issues are decided. This requirement carries the problem into a field which scientifically trained men are frequently reluctant to enter—that of publicity and propaganda. But unless educated citizens are prepared to make themselves competent in this field for the benefit of society at large, their efforts, no matter how wisely conceived, will be overwhelmed by the propaganda of pressure groups who pursue selfish interests and who frequently have the skill to clothe these interests in the robes of patriotism and public welfare. Educated citizens must learn to explain social problems as well as to solve them.

To my mind, therefore, acceptance of the principle of democracy implies a new emphasis in education and a new sense of responsibility of citizenship on the part of professional men, not only as individuals but also as organized professional groups. It seems to me necessary that there be a pervasive infiltration, among the citizenry, of professional people who will have become socially literate and who will feel the responsibility that goes with advantage and privilege; and further that professional groups hold constantly and pre-eminently in view their status as organic units of a democracy now under stress and their responsibility to help save it for future generations.

Then there are other grounds, I contend, on which engineers have an especial responsibility. In proposing these grounds, however, I hope I need not disclaim the supposition that engineers are self-righteous and endowed with special intellectual gifts and that therefore as a pro-

fessional group they are the hope of the world. There are, however, two special facts regarding engineers that place them in a unique position, and I need do no more than mention them to this audience. One is that the very nature of their professional work affects social organization. For example, in industrial management where they hold forth, social and economic problems loom large. Moreover, their technical achievements are associated with the origin of basic social problems—for instance, immediate technological unemployment and the rapid, fundamental alteration of the physical environment of society. Thus being the authors of, and therefore intimately understanding, the causes themselves, they should be in an advantageous position to learn how to control the effects.

The other special fact is the effectiveness of the engineer's method. The care and objectivity with which he approaches a problem, his insistence upon understanding its elements as far as may be practicable before deciding upon plans, the impartiality of his decisions, the firmness of his execution—these are certainly something to be desired in social and economic affairs. The discipline of dealing with facts and principles that demonstrate themselves—sometimes publicly, if the bridge fails—has been widely and justly praised as a commendable attribute of the engineer's calling. So I am only repeating a commonplace when I propose that there is undoubtedly something in the engineering method, the scientific method, that is wanting in many social procedures and that could with great profit be exercised there. But believing this, I yet know that it would be putting the doctrine of transfer of ability to severe stress to move the engineer with his present knowledge and method over into the social realm without an appropriate leavening of his mind with humane appreciation and social understanding. But with this, I am confident that his method would greatly reinforce the attack upon those social problems that are related to his fields, or are a part of them.

Thus his method and the social implications of his work are cogent reasons for his assuming greater social responsibility; and added to these is the fundamental proposition that responsibility is doubly implied in democracy—through his citizenship and his organized professional connections.

What might that responsibility be? In what ways might the engineer become socially more serviceable? I have already indicated this in general terms. To be more specific brings one close to the realm of speculation. What, for instance, might the engineer actually do as an educated citizen? Just what every other educated citizen should do: Keep informed regarding public issues, arrive at intelligent convictions, and give these as forceful expression as possible by such means as may be at his command. These means obviously include active cooperation with other citizens in the promotion of causes which appear sound; helping the masses understand; and taking a much more extensive hand in public service in his local community, or in state or national affairs.

Moreover, engineers are increasingly forced to assume social responsibilities incident to their professional service. Managers and promoters of new technical undertakings must, willy-nilly, take account of the social consequences of alternative approaches to problems which have to be solved, and because the social and the technical aspects of these problems are interwoven, the two must be handled concurrently. The engineer who is blind to the social implications of his work is a less efficient engineer when social problems are involved than the one whose analysis includes necessary social factors, because whether we like it or not these have become a part of engineering activity. The engineer's achievements in management on the material, technical, and economic sides have been magnificent, and he has frequently rendered notable service on the social side of his undertakings. In other cases, however, social ills, avoidable and unavoidable, have accompanied engineering progress, and it has become clear that the engineer has an important responsibility in helping to ameliorate these conditions. And in the midst of management he certainly is in a most favorable location to do so.

And finally as a member of organized engineering groups he might together with his colleagues exert telling influence upon important national problems. Most certainly in those which involve engineering elements he should have a strong voice in the forming of policy as well as the responsibility for technical plans. And more general still, he should be represented on equal footing with other professions on commissions and councils of government that might work out intelligent recommendations regarding long-range policy on which legislative bodies or administrations might act. In other words, wherever intelligent group procedure is required in connection with the problems of the democracy, the engineer should be represented.

But what can be said of the view one occasionally meets that the engineer's business is engineering, and that social and economic matters should be left to the social scientist? There is no berth in my mind for this opinion for two reasons: It stretches too far the theory of the division of labor, and it contravenes the principle of democracy. Experience proves division of labor to be sound in the building of a gun or automobile, but not where the business is settling what human relationships and human interests should be. It is one thing to have the several operations of shaping and assembling material parts done independently by different individuals according to an organized plan, and quite another to try to make the general plan itself by that method. And this is what we are discussing. Of course we should say that the strictly technical business of the social scientist should be done by him, of the engineer by the engineer, and of every other profession by that profession. But there are two things we must not do. We must not try to bound professional fields by straight lines when the boundaries are inherently irregular zones; rather we must articulate effectively those protruding areas at the boundary that should extend continuously from one field to another so that the whole pattern might represent an integrated, organic, social unit. And secondly, we must not confuse expertness in a particular field with qualification for forming general judgments as to social policy and plan. The medical profession should

not itself decide whether we should have socialized medicine, but it should submit to a representative professional body the technical implications of such a policy; the legal profession should not itself decide upon laws, but certainly should deal with the technical business involved in their preparation and interpretation; the engineering profession should not itself decide whether we should have TVA, but certainly should make and interpret the results of its calculations; and the social scientist should not decide whether we should have a Federal Housing Authority, but should obviously make and submit his technical findings in relation thereto. Each profession must of course be responsible for technical expertness, and up to this point the theory of the division of labor is applicable; but no profession can be depended upon alone for judgments that involve interests and factors extending beyond its purview. And since there is not a super-profession—for most of us do not accord to social scientists this distinction—to which can be assigned the job of forming over-all judgments and framing recommendations of wise policy and plan, the theory of the division of labor is found wanting at that point. Anyway, in a democracy, who is the social scientist to determine alone what social policy and plan should be? who the engineer? the business man? who indeed? None is competent. The job is too big, the ramifications of interest too extensive. But even if one were competent, it would contravene the principle of democracy to have proposed policy arrived at that way. Without a super-profession, and presumably without a dictator, to do our thinking for us, and yet with problems of social policy and plan so complex that expert professional thinking must be given to them, we are, it seems to me, inevitably committed to the more clumsy but democratic scheme of conference or council for reaching intelligent proposals in which the people, or legislative groups, might have confidence. Thus such councils would provide technical expertness, balance of interests, and the effective joining of boundary connections between related fields of social activity. All of these are essential and they cannot be achieved through the policy of professional isolation. The engineer cannot delegate his responsibility to the social scientist.

But it is idle to talk about social responsibilities which the engineer might assume unless there be some prospect of getting him interested. This is the crux of the matter. I do not have the answer, but I do have a theory. I am clear, in the first place, that there is very little prospect of getting him actively interested by talk. Discussion and exhortation seem ineffectual in exciting in mature man a new interest—one that will bring action along a line fundamentally different from that of the past. Why this is so is a matter for the biologist and psychologist; the explanation is not important here, but the fact itself is. Hence I see only little hope in discussion; most mature men are going to continue doing what they have done.

My theory is that active interest will follow competence. Given understanding and intellectual competence in the matter, interest will follow. If my observations are trustworthy, graduates follow essentially the interests they have cultivated in college; if not those within the immediate boundaries of the profession itself, then at least those of both subject matter and method that in college demanded a significant part of their attention. For illustration, in law such matters as social relationships and organization, business, finance, and discipline in careful statement are associated directly with the study of law itself. Graduates of law pursue legal practice, but they also gravitate to general management, politics, and banking. In medicine, on the other hand, there is little associated with the study of this field that is, at the same time, related so directly to fields outside the profession itself. And graduates of medicine, forming perhaps the most closely knit of the professions, stick close to medicine. In engineering again we have diversity. Planning based on clear-headed objective study and calculation, and the execution of plans, all in connection with material things—these have characterized the dominant interests of engineering students. And the graduates engage not only in technical pursuits, but also in industrial management and business. The question may be legitimately raised whether particular interests are pursued in college and afterward because they are inherent, or whether pursuit in college creates the interest. But the question has little point. The inference we have drawn is that whether the interest exists beforehand or is created, it is nevertheless cultivated in college and this cultivation profoundly influences the direction of later activity.

Here at least is a theory as to how the engineer's interest might be won. It means turning to youth; it means turning to education. If it is essential to the maintenance of a democratic society and to progress in solving baffling social problems to have the talents and the active citizenship of engineers focused upon those problems, habits must be formed in college, interests stimulated, and competences developed which will enable the engineer to co-operate naturally and effectively with educated citizens from other fields who are working toward the same ends.

This theory places responsibility for the initial step in the process squarely upon the shoulders of engineering educators, and this is a heavy and pointed responsibility. The initial step is difficult to take for reasons I have already stated, but unless we are to be in the position of shirking responsibility and of drifting in the face of danger under a policy of technical self-sufficiency, we must act. We must provide in the curriculum enough time and sufficient guidance of the right kind so that our engineering students will have reasonable opportunity to prepare themselves for the responsibilities they will meet in the day they reach professional maturity. If our national situation is difficult to understand and deal with, theirs will be more so; and we must help them get ready.

I need not repeat here the difficulties involved in the fundamental revision of the curriculum. Inadequate time, rigidity of view, vested interest, unwarranted insistence upon specialized skills and knowledge—all of these loom ominously at the first move toward change. I know what they are. But I am clear that we can immensely improve engineering education toward the ends of social understanding and at the same time toward the ends of engineering science and method, and still keep

the process within the present framework of undergraduate and graduate study.

I have just said that the responsibility upon engineering educators is heavy and pointed. Other professions may permit the creeping ossification of view to blind them in their mature years to the necessity of change and readjustment, but if the United States is to emerge from chaos and endure as a democracy, as a land of free men, then each new professional generation must be nurtured not in the same atmosphere and professional lore as their fathers and grandfathers but in the light and knowledge and purpose of their own day. And if this is to be so, then the teaching profession must make it so. The responsibility cannot be evaded.

Human Relationships

ADAM S. BENNION

Some of the human relationships involved between management and workers, business and its customers, and business and government are discussed here by a prominent power-company executive, who takes as his text the statement that "the strength of human feeling is still the most potent of all forces affecting the affairs of the world."

IT WAS my privilege to be in New York City on the day the King and Queen of Great Britain were tendered their great reception. I was not particularly surprised, therefore, when upon their arrival back home in London the King made the following remarkable statement:

"The detailed story of our travels is familiar to you by the daily press, the news reels, and the broadcasting corporations which, on both sides of the Atlantic, have reported it with accuracy and sympathetic understanding. I shall only try to tell you some of the impressions of my journey that remain in my mind. First, and deepest, is that even in this age of machines and mass production the strength of human feeling is still the most potent of all forces affecting the affairs of the world."

I take this statement as my text.

The history of the United States, brief as it is, is rich in achievement. We have faced problems of pioneering—of financing—of engineering—of construction—of selling—of accounting. All these are essential to the progress we have made. Just now, however, a new problem is conspicuous—not that it is entirely new, for it has always been important, but just now it is taking on added significance. Crises always serve to emphasize human relationships. That is true whether in the home, or in the school, or in the community. Crises test the fiber of men. When things go wrong it is natural for us to fix the responsibility—to blame somebody—to urge new panaceas. Certainly the difficulties of the last ten years have stirred up strife among men.

We have faced great human problems before. We faced them in the days of the American Revolution, when men fought for liberty. We faced them in the days when those same men struggled to formulate the foundations of our constitutional procedures. We faced these same problems in Civil War days, when men again fought to establish equality and to preserve our freedom.

In these last ten years men have been engaged in one more great struggle—this time for greater security and for a more equal share of the benefits of civilization. Civilization works in pendulum swings. For the last ten years we have been swinging in the direction of increased social privileges. Attempts have been made to safeguard men against unemployment, old age, sickness, and kindred dreads. America has been given a new social consciousness toward these responsibilities. In my judgment, business hereafter will always be more mindful of its human problems than it has ever been before. Unfortunately, sociological procedures are not quite so scientific as engineering procedures. No doubt we shall make mistakes. We need to counsel together on what I think is the biggest problem before America today: how to attain a sensible degree of social security without endangering the very principles upon which American civilization has been built.

Certainly that civilization has rested to date upon the driving force of individual initiative and freedom of enterprise. Whatever its shortcomings may be, American industry has built of this country the most outstanding nation in the world today. No totalitarian scheme can take credit for American achievement. No such scheme elsewhere in the world can match what America has done. The fact that problems exist should not lead us to destroy our pattern of living. Let's briefly look at some of our

Essential substance of an address presented at the general session of the AIEE combined summer and Pacific Coast convention, San Francisco, Calif., June 26–30, 1939.

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human relationships in an attempt to discover what the problems are and what may best be done about them.

FIRST of all, there is the problem of management and men. For some time I have been working in an organization which has recently been unionized, and therefore I come to you with full sympathy toward labor. I am convinced that working together men and management may build a great future. Working at cross purposes they can make progress impossible. The history of labor reveals very clearly that the laboring man is gradually coming into a better world. It is interesting to note that the summary of a survey of manufacturing institutions employing 8,000,000 men shows that in 1914 factory employes averaged 24¢ an hour; in 1937 the average was 71¢. In that same period their work week was cut from 51 hours to 40 hours. Whereas in 1914 they received a weekly pay check of $12.72, in 1937 they were getting a pay check 128 per cent higher. Then, too, men have been coming into a greater voice in the direction of the institutions with which they are connected. Great strides have been made since the days of slavery and serfdom. No doubt further adjustments will still be worked out. We need further understanding between management and men. Management needs to be more sympathetic; needs to be clearer in its provisions for the welfare of men. But men, also, need to be more mindful of the problems of management, its hazards, its responsibilities. In my judgment, if we ever needed in human relationships the genius of engineering technique, we need it right now. Men and management more than ever need to sit down around a common table to discuss their mutual relationships. These are not so simple as some men would have us believe. Management rests upon capital, and capital goes to work much as men do—only when the rewards justify it. Capital involves tremendously more than mere money; it involves creative ideas; it involves the genius of organization and managerial direction.

Statisticians are discovering that some $8,000 on the average must be invested to give employment to a single man. Money must be invested if men are to work. Idle money, lying in the banks—afraid to go to work or with returns so low that they do not encourage money to come out of the cellar—these things explain why so many men are idle in America today. It becomes increasingly clear that any program which threatens and browbeats money on the one hand and attempts to put men to work on the other is doomed to failure. The laboring man, in his own defense, should encourage the use of money at a reasonable return. It is foolish for men to condemn the agencies that in the last analysis must provide them the privilege of working.

There are other problems that need to be jointly thought through by management and men. Men need to know the costs involved in doing business—costs of the use of money; costs of rent; costs represented in taxes, in materials and supplies.

We talk a very great deal about profit-sharing. In all fairness we ought to talk also about loss-sharing, because the American plan of business is not just the profit plan—it is the profit-and-loss plan. Men need to be helped to understand more fully how wages are fitted into the general scheme of these costs. Then, too, further study needs to be made of the question of wages themselves. Who ought to be paid what and why? What is a man really worth? Measured in terms of responsibility, or of earnings, or of hazard, what should a given job pay?

Men generally are reasonable. They will want to do the fair thing when they understand. They need further to understand the complications of business. Management, too, must come into a fuller appreciation of its responsibilities to men. More careful study needs to be made of working conditions, of wage scales, of training on the job, and of provisions against sickness, accident, and old age. Certainly arbitrary rulings have been made in the past and human feelings all too frequently have been ignored. Together men and management can find sensible answers to all these problems. A willingness to give and take will find a solution to almost any one of them. Certainly it is primitive to proceed on a basis of shutdowns, layoffs, arbitrary disciplining on the part of management. It is equally primitive to resort to strikes and picketing on the part of men. Reason and sympathetic understanding are still our best guarantees toward a sensible answer in this first field of human relations.

THERE is a second outstanding problem in the field of industry—the relationship between institutions and their customers. After all, institutions are set up to be of service to people. It is an odd thing to witness the spectacle of institutions condemning the people they serve, or of people stirred to hatred against the institutions which would serve them. Unfortunately, when the crack-up of 1929 occurred, business was charged with the major responsibility for the failure. Men and women have been taught not only to distrust business, but to hate it; and yet the prosperity of America is the prosperity of her business institutions. Confidence is the keynote either to recovery or to sustained progress.

We are gradually learning, too, that businesses go hand in hand. Whenever one fails, all others are made to suffer.

I pay my tribute, in passing, both to the men in business and to the customers whom they serve. Both groups, by and large, are fair. Again it is a question of mutual understanding. There is no magic about public relations. There is no new panacea and no new device that will work out free from difficulties. Business needs to be more mindful of its customers; needs to do a better job of service; needs to treat its customers more as guests. May I quote one of the best statements I have yet encountered in the field of improved relationships between institutions and their customers:

"It is no longer sufficient that business produce goods or services of the kind customers want at a price that customers can pay. Although heaven knows that in itself is hard enough to do. In addition—and here we break into a new field of management re-

sponsibility—business must provide and dispense those goods and services in a manner to win general approval and under circumstances that will promote social as well as economic progress. The great lesson that business is learning is that people are interested in more than just the product and the price. They are interested in the way things are done, in what might be called the social products of industry.

"Defined broadly, good relations with the consuming public is not something that industry can achieve through publicity or through the activities of a particular department of the organization. Public relations is not a specialized activity like production, engineering, finance, sales. It is rather something that cuts through all these as the theme for each. It is an operating philosophy that management must seek to apply in everything it does and says. It is the philosophy of saying sincerely things people like—and saying them the way they like. It is more. It is the philosophy of doing things people like—and doing them the way they like. And, remember this, the doing is more important than the saying. But the doing alone is not enough."

(—*Paul W. Garrett, General Motors Corporation*)

Would you read further into this field, turn to "Ten Ways to Make Your Customers Like Your Company," by James E. Davidson (A'17, M'17), president of the Nebraska Power Company (*Bulletin* of the Edison Electric Institute, volume 6, 1938, pages 284–6).

SO FAR we have touched briefly on two of the outstanding problems in the field of human relationships: the problem of management and men, and the problem of the relationship between institutions and their customers. May we turn now, briefly, to a third consideration, namely, the relationship between business and government.

No one can face the developments of the last few years and not be aware that that is one of the greatest problems in America. There was a time, if I can clearly read the history of my country, when the primary business of government was to do what men could not do for themselves. Now there seems to be a tendency to let government do whatever government may aspire to do. Business finds itself in competition with its government at so many turns nowadays that one really wonders whether government proposes to take over the whole field of business. It is interesting to review the story of Egypt, and of Assyria, and of Babylonia, and of Greece, and of ancient Rome. All that happened to those countries should lead us to pause. We have had our constitutional government for only 150 years. We are a young nation as civilization is chronicled, and yet, we are following the tendencies that have cracked up all the civilizations referred to. They cracked up economically. They rolled up tremendous debts from which they could find no release. In our own country we have piled up a tremendous debt. Our government has entered into fields of competition with scores of its industries. There is a growing disposition to center more and more of our activities in Washington. I don't argue that the government cannot run the railroads or the telephones. I am aware that the government can operate the power business. The government, too, can furnish us with food and clothing, if it chooses. But once the government does all these things, American democracy becomes a memory.

Let me illustrate out of my own field. Certainly there the government has overreached its original boundaries. In the name of a yardstick experiment it has plunged into a program with the Tennessee Valley Authority which threatens to socialize the whole power program. You hear no more of the yardstick these days. Evidently it has been lost in the schemes of reforestation, of flood control, and of social rehabilitation. Let's look at a concrete example. The government is faced with the problem of flood control, or of reclamation. In the natural course of its development it must build a dam. A natural result is the production of power. I have no quarrel with the program up to that point; but when the power is produced, what need is there for the government to set up its own agency for distribution when to do so it must destroy agencies that have already done the work of pioneering and of building up the territory? Does the government say, "The eosts are out of line"? Certainly these costs can be determined and controlled without crucifying existing institutions. Does the government say, "We must extend service to the frontiers"? Certainly that is a worthy purpose. But the government, again, can do this work of reaching out to the far corners either by way of gifts or by way of subsidies to agencies already established. In the American scheme of things it is always fine to see that we have an umpire to see that the game is played fairly. It is an American practice in baseball, basketball, tennis, and football. But when Uncle Sam aspires to play left halfback on the football field—when he takes the ball under his arm and heads toward the goal—at the same time presuming to be the umpire—sooner or later that practice will develop into a rotten game.

In order that this may not stand as a mere negative criticism, may I close this discussion with a few constructive suggestions which, in my judgment, will promote the relationship between government and business:

First, let the government concern itself with problems that everybody will agree belong to it, such as national defense, highway construction, reforestation, and the preservation of law and order.

Second, let it withdraw from activities in which it finds itself in competition with private agencies already established and doing a creditable job.

Third, if it desires to extend benefits and services, let the government do so through agencies that have already been built up in the spirit of American industry and that to date have made this country possible, and that now propose to sustain it.

Fourth, let the government cease its industrial indictments and its appeals to class animosities.

Fifth, let the government set industry free to expand not in words only, but in performances that make its words ring true.

Much has been said in recent years about driving money changers from the Temple. I am aware of that quotation. But it does not represent its Author at His best. That same Man, under the stress of a very vexing situation, declared as He meditated: "He that is without sin, let him cast the first stone."

In this good land of ours, in the spirit of Him who is responsible for both statements, we need a little less of the reformer and a lot more of the Redeemer.

Principles Underlying the AIEE Model Registration Law

1. Legislation of this type is enactable only for the public benefit and should be limited to that objective. Any benefit to the profession should be incidental.

2. Legislation is prefaced with statement of purpose. The purpose of enactments on engineer licensing usually reads "in order to safeguard life, health, and property." Enactments should avoid embodying provisions beyond the stated purposes and for unnamed ulterior objectives because such provisions would depart from the basic principle of truth which is the keystone of ethical engineering practice.

3. Public benefit will be protected in the maximum possible degree if it is assured that those who offer engineering services to the public are competent to render the service contemplated. Legislation can assure that certain minimum standards of competence exist and can provide for enforcement. It cannot attempt more than this. The public must determine for itself any necessity for competence in excess of the minima. Higher development of engineering competence beyond these minimum requirements continues to be the objective of engineering educational institutions and engineering societies, and its attainment is assured without legal requirement.

4. To assure these conditions it is not necessary that all engineers be subject to legislation but only those who offer service for hire, or are public employees.

5. The practices of engineering may be broadly classified as:

A. Those in which engineering service is the final objective as a business enterprise and for profit.

B. Those in which engineering is but one of several elements in the final product of an enterprise.

6. In classification A the engineer must assume final responsibility. In this class are the so-called "professional engineers" who offer professional service to the public for hire, either to individuals of the public or who are engaged in the execution of *public* projects as employees of the State or of the political subdivisions thereof.

7. In classification B the responsibility lies with the organization as a whole. In this class are the engineers (research, design, planning, or construction), for example, in the employ of manufacturers, utilities, and educational institutions. Here engineering is the means to an end. The final decisions and responsibility lie with these legally responsible corporations and are exercised by their executives as to the work of all employees including engineers.

8. Intermediate between these two groups is the structural engineer who is responsible, even as an employee, for approving or filing plans for structures in which the public safety is involved.

9. That the benefit of the public is served by regulation of engineers of classification A and of the structural engineer is clearly evident. That it is served by regulation of the employee engineer of classification B is not evident.

10. In neither of the frequently cited professions of law and medicine is regulation employed except of those in public relation. The misunderstandings arise probably from the relatively small fraction of those other professions which is not in public relation as compared with the large proportion of the engineering profession without public relation.

11. It may well be that some engineers not in public relation will, for their own reasons, elect to register under provisions of the enactment, but the choice should be with them individually.

12. The effect of legislation should be the fixing of a minimum engineer competence as the result of engineering training and experience in practice. There should be no attempt in this legislation to grade institutions, nor to control curricula and degrees and matriculation. The determination of curricula should lie within the educational institutions. Legislation should not be designed to limit the development of engineering schools nor the matriculation of engineering students, nor to promote the economic and social status of the engineer.

13. There should be no objective in legislation of control of the engineering societies and their grades of membership, nor of requiring registration as a condition of membership.

14. Reciprocity between States in admitting registered engineers to practice elsewhere than in the State of their registration should be encouraged.

15. The cost of licensing should be lowered. Proper budgetary control of expenditures should be provided.

16. Minimum curricula and experience requirements common to various branches of engineering and affecting public interest should be set up. Further examinations of applicants in various branches should be pertinent only to that branch of engineering in which they specialize and practice.

November 15, 1937

A Model Law for the Registration of Engineers

C. R. BEARDSLEY
FELLOW AIEE

AT THE summer convention meeting of the AIEE board of directors June 29, 1939, at San Francisco, Calif., the June 1, 1939, AIEE draft of Model Law for Registration of Engineers was adopted by unanimous vote. Therefore it appears timely to outline the origin and development of this draft, and to indicate how it may be used.

The AIEE has been represented for many years on joint committees drafting model laws for the licensing of engineers. Institute representatives have not endorsed in entirety any of the various drafts that have been prepared. The reason preventing endorsement was the belief that the model law for licensing engineers should limit the licensing requirement to cases where the protection of the public safety, health, and property is involved and should not require the licensing of all engineers regardless of whether or not they have direct relationship to those public questions. In the case of electrical engineering, a predominating proportion of the work is of such nature that licensing has no justification insofar as protection of the public is concerned. A licensing law should not be designed as a means for achieving or increasing professional unity. These considerations are set forth more fully in the statement of principles appearing on the facing page.

The AIEE board of directors, therefore, has not approved any of the drafts prepared by the joint committees to which it has sent representatives. Those drafts did not provide sufficiently for exemption.

In 1937 the AIEE board of directors authorized the preparation of a draft of a model law. A committee was appointed, consisting of C. R. Beardsley, *chairman*, T. F. Barton, and H. S. Osborne. The preliminary statement of principles was unanimously endorsed and became the basis of the draft. Mimeographed copies comparing this draft with the earlier drafts of the joint committees were sent to AIEE Sections for comment. Suggestions and comments were considered by the committee and as far as feasible were incorporated in the draft adopted at San Francisco and printed on these pages.

In states which already have adopted laws, this draft may prove useful in considering the amendments frequently proposed in state legislatures. AIEE Sections may decide to appoint committees on legislation to watch such amendments and take appropriate action on local matters. Such action, limited to local problems, issues, and initiative, should not involve the national organization.

In states where no laws exist, but may be in prospect, the AIEE Model Law may be useful to those engineers whose influence may be brought to bear in formulating proposed statutes.

The AIEE committee on Model Law has been merged with and has become a subcommittee of the Institute's committee on legislation affecting the engineering profession. Sections are encouraged to refer criticism or questions for advice to this committee.

June 1, 1939, AIEE Draft of a Model Law

TITLE: An Act to regulate the practices of professional engineering and land surveying;† creating a State Board of Registration for Professional Engineers and Land Surveyors; defining its powers and duties; imposing certain duties upon the State and political subdivisions thereof in connection with public work; and providing penalties.

Section I. General Provisions*

Be it enacted by the General Assembly of the State of ...., that in order to safeguard life, health, and property any person practicing or offering to practice professional engineering or land surveying[1] shall hereafter be required to submit evidence that he is qualified so to practice and shall be registered as hereafter provided; and it shall be unlawful for any person, not duly registered under the provisions of this Act, to practice or offer to practice in this State professional engineering or land surveying as defined in the provisions of this Act, or to use in connection with his name or otherwise assume use or advertise any titles or description implying that he is a professional engineer or land surveyor.

Section II. Definitions

Engineer: The term engineer as used in this Act shall mean a professional engineer as hereinafter defined.

Engineering: The term engineering as used in this Act shall mean professional engineering as hereinafter defined.

*Public employment:** The term public employment as used in this Act shall mean engagement in the execution of public projects as employee of the State or of a political subdivision thereof.

*Professional engineer:** The term professional engineer as used in this Act shall mean a person who is qualified and registered[2] under the provisions of this Act to engage in the practice of professional engineering as hereinafter defined.

*Professional engineering:** The practice of professional engineering within the meaning and intent of this Act includes any pro-

† In States where it is considered unconstitutional to include surveyors in the same registration act with engineers, a separate act should be prepared for surveyors and the necessary changes made in this Act so that it will provide for engineers only.

* Asterisks occurring throughout this draft indicate difference in intent from the August 1938 draft.

1. Land surveying does not involve matters that would ordinarily jeopardize life and health, but property rights are vitally affected by land surveying, and many States have deemed it essential to place restrictions and safeguards about its practice. Surveying is a function of engineering, but land surveying deals with land measurements involving property rights.

2. The words "and registered" were added because the fact of a person being qualified does not in itself make him subject to registration. Whether or not he is a professional engineer depends on the use he makes of his ability and experience. Certain private employments of engineers may be similar in functions to those of professional engineering yet should not render engineers in private employment subject to the requirements of registration.

fessional service for hire to the public or in public employment, such as consultation, investigation, evaluation, planning, design, or responsible supervision of construction or operation, in connection with any structures, buildings, machines, equipment, processes, works, or projects, wherein the safeguarding of life, health, or property is concerned or involved when such professional service requires the application of engineering principles and data.[3]

Land surveyor: The term land surveyor as used in this Act shall mean a person who engages in the practice of land surveying as hereinafter defined.

Land surveying: The practice of land surveying within the meaning and intent of this Act includes surveying of areas for their correct determination and description, for conveyancing, or for the establishment or re-establishment of land boundaries and the plotting of lands and subdivisions thereof.

Board: The term "Board" as used in this Act shall mean the State Board of Registration for Professional Engineers and Land Surveyors, provided for by this Act.

Section III. Board: Appointment, Terms*

A State Board of Registration for Professional Engineers and Land Surveyors is hereby created whose duty it shall be to administer the provisions of this Act. The Board shall consist of five professional engineers, who shall be appointed by the Governor from among nominees recommended by a panel of engineering societies selected by the Governor of this State and shall have the qualifications required by section IV. The members of the first Board shall be appointed within ninety days after the passage of this Act, to serve for the following terms: one member for one year, one member for two years, one member for three years, one member for four years, and one member for five years, from the date of their appointment, or until their successors are duly appointed and qualified. Each member of the Board shall receive a certificate of his appointment from the Governor and before beginning his term of office shall file with the Secretary of State his written oath or affirmation for the faithful discharge of his official duty. Each member of the Board first appointed hereunder shall receive a certificate of registration under this Act from said Board. On the expiration of the term of any member, the Governor shall in the manner hereinbefore provided appoint for a term of five years a registered professional engineer, having the qualifications required by section IV, to take the place of the member whose term on said Board is about to expire. Each member shall hold office until the expiration of the term for which such member is appointed or until a successor shall have been duly appointed and shall have qualified.

Section IV. Board: Qualifications

Each member of the Board shall be a citizen of the United States and a resident of this State, and shall have been engaged in the practice of the profession of engineering for at least 12 years, and shall have been in responsible charge of important engineering work for at least 5 years. Responsible charge of engineering teaching may be construed as responsible charge of important engineering work.

Section V. Board: Compensation, Expenses

Each member of the Board shall receive the sum of $........... per diem when actually attending to the work of the Board or any of its committees and for the time spent in necessary travel; and, in addition thereto, shall be reimbursed for all actual traveling, incidental, and clerical expenses necessarily incurred in carrying out the provisions of this Act.[4]

Section VI. Board: Removal of Members, Vacancies

The Governor may remove any member of the Board for misconduct, incompetency, neglect of duty, or for any other sufficient cause. Vacancies in the membership of the Board shall be filled for the unexpired term by appointment by the Governor as provided in section III.

Section VII. Board: Organization and Meetings

The Board shall hold a meeting within 30 days after its members are first appointed, and thereafter shall hold at least .... regular meetings each year. Special meetings shall be held at such time as the bylaws of the Board may provide. Notice of all meetings shall be given in such manner as the bylaws may provide. The Board shall elect or appoint annually the following officers: a chairman, a vice-chairman, and a secretary.[5] A quorum of the Board shall consist of not less than three members.

Section VIII. Board: Powers*

The Board shall have the power to adopt and amend all bylaws and rules of procedure, in accordance with the Constitution and Laws of this State, which may be reasonably necessary for the proper performance of its duties and the regulations of the proceedings before it.[6] The Board shall adopt and have an official seal.

In carrying into effect the provisions of this Act, the Board, under the hand of its chairman and the seal of the Board, may subpoena witnesses and compel their attendance, and also may require the production of books, papers, documents, and so forth, in a case involving the revocation of registration or practicing or offering to practice without registration. Any member of the Board may administer oaths or affirmations to witnesses appearing before the Board. If any person shall refuse to obey any subpoena so issued, or shall refuse to testify or produce any books, papers, or documents, the Board may present its petition to such authority[7] as may have jurisdiction, setting forth the facts, and thereupon such authority shall, in a proper case, issue its subpoena to such person, requiring his attendance before such authority and there to testify or to produce such books, papers, and documents, as may be deemed necessary and pertinent by the Board. Any person failing or refusing to obey the subpoena or order of the said authority may be proceeded against in the same manner as for refusal to obey any other subpoena or order of the authority.

Section IX. Board: Receipts and Disbursements*

The secretary of the Board shall receive and account for all moneys derived under the provisions of this Act, and shall pay the same monthly to the State Treasurer, who shall keep such moneys in a separate fund to be known as the "Professional Engineers' Fund." Such fund shall be kept separate and apart from all other moneys in the Treasury, and shall be paid out only by ....[8] All moneys in the "Professional Engineers' Fund" are hereby specifically appropriated for the use of the Board. The secretary of the Board shall give a surety bond to the State in such sum as the Board may determine. The premium on said bond shall be regarded as a proper and necessary expense of the Board, and shall be paid out of the "Professional Engineers' Fund." The secretary of the Board shall receive such salary as the Board shall determine in addition to the compensation and expenses provided for in section V. The Board may employ such clerical or other assistants as are necessary for the proper performance of its work, and may make expenditures of this fund for any purpose which in the opinion of the Board is reasonably necessary for the proper performance of its duties under this Act, including the expenses of the Board's delegates to annual conventions of, and membership dues to, the National Council of State Boards of Engineering Examiners. Under no circumstances shall the total amounts of warrants issued by ....[9] in payment of the expenses and compensation provided for in this Act exceed the amount of the examination and registration fees collected as herein provided.

The total of warrants issued in any calendar year shall be limited by budget authorization duly prepared and authorized by .... (proper official or body). Excess of receipts over budgeted authorization shall be held by .... (proper official) in a special reserve item of the "Professional Engineers' Fund," until the reserve item of the fund amounts to a maximum of $........... Thereafter

3. The essential thought of this paragraph is that licensable engineering is characterized and defined by its employment for hire by the public. It is in such employment that the safety, health, and property of the public require the protection inherent in competent engineering service. The words "public welfare" used in other drafts were excluded as being indefinite and susceptible to too broad interpretation. This clause originally included words "public or private utility" but the definition was deemed complete without them. Also there is variation in the meaning of this term and confusion might result therefrom.

4. The per diem allowance of members of the Board is not indicated nor is it intended to be fixed as a commensurate compensation for the services to be rendered. High-grade professional men are expected to serve as a matter of good citizenship.

5. It is deemed advisable to have a member of the Board fill the office of secretary, but as provided in section IX, the Board may appoint an assistant secretary, executive secretary, treasurer, or other officer, not a member of the Board, to whom clerical and administrative duties may be assigned.

6. The phrase "in accordance with" existing laws confines bylaws and interpretations to the provisions of enactments. To authorize a board to adopt rules "not inconsistent with" existing laws permits wide latitude in power of new extensions of interpretation.

7. "Authority" may be replaced by the designation of the proper court or other suitable judicial unit.

8. Insert title of proper State official, and method of authentication and payment.

9. Insert title of proper State official.

the Board shall cause to be made such a reduction of fees, that the return therefrom shall not exceed that necessary for the proper function of the Board.[10]

Section X. Board: Records and Reports

The Board shall keep a record of its proceedings and a register of all applications for registration, which register shall show: (*a*) the name, age, and residence of each applicant; (*b*) the date of the application; (*c*) the place of business of such applicant; (*d*) his educational and other qualifications; (*e*) whether or not an examination was required; (*f*) whether the applicant was rejected; (*g*) whether a certificate of registration was granted; (*h*) the date of the action of the Board; and (*i*) such other information as may be deemed necessary by the Board.

The records of the Board shall be prima facie evidence of the proceedings of the Board set forth therein, and a transcript thereof, duly certified by the secretary of the Board under seal, shall be admissible in evidence with the same force and effect as if the original were produced.

Annually, as of .... (insert date), the Board shall submit to the Governor a report of its transactions of the preceding year, and shall also transmit to him a complete statement of the receipts and expenditures of the Board, attested, by affidavits of its chairman and its secretary.

Section XI. Roster*

A roster showing the names and places of business of all professional engineers and all land surveyors registered under this act shall be published by the secretary of the Board during the month of .... of each year. Copies of this roster shall be mailed to each person so registered, placed on file with the Secretary of State, and furnished to the public upon request and to county authorities and to the authorities of the principal cities of the State.

Section XII. General Requirements for Registration

The following shall be considered as minimum evidence satisfactory to the Board that the applicant is qualified for registration as a professional engineer or land surveyor, respectively; to wit:

(1) As a professional engineer:

(*a*) *Engineers—graduation plus experience**

Graduation from an engineering curriculum of four years or more in a school or college which curriculum school or college shall have been approved as of satisfactory standing by the Board or by the National Council of State Boards of Engineering Examiners, or by the National Bureau of Engineering Registration, or by the Engineering Council for Professional Development; and a specific record of an additional four years or more of experience in engineering work or a character satisfactory to the Board, and indicating that the applicant is competent to practice professional engineering (in counting years of experience, the Board at its discretion may give credit, not in excess of one year for satisfactory graduate study in engineering)[11] or

(*b*) *Engineers—examination plus experience*

Successfully passing a written, or written and oral, examination designed to show knowledge and skill approximating that attained through graduation from an approved four-year engineering curriculum; and a specific record of eight years or more of experience in engineering work of a character satisfactory to the Board and indicating that the applicant is competent to practice professional engineering.

(*c*) *Engineers of long-established practice*

A specific record of 12 years or more of lawful practice in professional engineering work of a character satisfactory to the Board and indicating that the applicant is qualified to design or to supervise construction of engineering works and provided applicant is not less than 35 years of age.

(2) As a land surveyor:

(*a*) *Land surveyors—graduation plus experience*

Graduation from a school or college approved by the Board as of satisfactory standing, including the completion of an approved course in surveying; and an additional two years or more of experience in land-surveying work of a character satisfactory to the Board and indicating that the applicant is competent to practice land surveying; or

(*b*) *Land surveyors—examination plus experience*

Successfully passing a written, or written and oral examination in surveying prescribed by the Board; and a specific record of six years or more experience in land-surveying work of a character satisfactory to the Board and indicating that the applicant is competent to practice land surveying.

(*c*) *Land surveyors of long-established practice*

A specific record of ten years or more of lawful practice in land-surveying work of a character satisfactory to the Board and provided applicant is not less than 30 years of age.

Character: No person shall be eligible for registration as a professional engineer, or land surveyor, who is not of good character and reputation.

Teaching credits: In considering the qualifications of applicants, engineering teaching may be construed as engineering experience.

Education credits: The satisfactory completion of each year of an approved curriculum in engineering in a school or college approved as of satisfactory standing by the Board or by the National Council of State Boards of Engineering Examiners, or by the National Bureau of Engineering Registration, or by the Engineering Council for Professional Development, without graduation, shall be considered as equivalent to a year of experience in section XII (1) (*b*). Graduation in a curriculum other than engineering from a college or university of recognized standing may be considered as equivalent to two years of experience in section XII (1) (*b*); provided, however, that no applicant shall receive credit for more than four years of experience because of undergraduate educational qualifications.

Non-practicing applicants: Any person having the necessary qualifications prescribed in this Act to entitle him to registration shall be eligible for such registration although he may not be practicing his profession at the time of making his application.

Section XIII. Applications and Registration Fees

Applications for registration shall be on forms prescribed and furnished by the Board, shall contain statements made under oath, showing the applicant's education and detail summary of his technical work, and shall contain not less than five references, of whom three or more shall be engineers having personal knowledge of his engineering experience.

The registration fee for professional engineers shall be $.........., $.......... of which shall accompany application, the remaining $......... to be paid upon issuance of certificate. When a certificate of qualification issued by the National Bureau of Engineering Registration is accepted as evidence of qualification, the total fee for registration as professional engineer shall be $...........

The registration fee for land surveyors shall be $..........., which shall accompany application.

Should the Board deny the issuance of a certificate of registration to any applicant the initial fee deposited shall be retained as an application fee.[12]

Section XIV. Examinations

When oral or written examinations are required, they shall be held at such time and place as the Board shall determine. If examinations are required on fundamental engineering subjects or land surveying (such as are ordinarily given in college curricula) the applicant shall be permitted to take this part of the professional examination prior to his completion of the requisite years of experience in engineering work or land surveying, and satisfactory passage of this portion of the professional examination by the applicant shall constitute a credit for a period of ten years.

The scope of the examinations and the methods of procedure shall be prescribed by the Board with special reference to the applicant's ability to design and supervise engineering works so as to insure the safety of life, health, and property. Examinations shall be given for the purpose of determining the qualifications of applicants for registration separately in professional engineering and in land surveying. At the discretion of the Board examinees may be permitted to select questions pertinent to their particular specialty in engineering practice. A candidate failing on examination may apply for re-examination at the expiration of six months and will be reexamined without payment of additional fee. Subsequent examination may be granted upon payment of a fee to be determined by the Board.

Section XV. Certificates, Seals*

The Board may issue a certificate of registration, upon payment of registration fee as provided for in this Act, to any applicant who, in the opinion of the Board, has satisfactorily met all the requirements of this Act. In case of a registered engineer, the certificate shall authorize the practice of "professional engineering," and in the case of a registered land surveyor, the certificate shall authorize the practice of "land surveying." Certificates of registration shall show the full name of the registrant, shall have a serial number, and shall be signed

10. The additional clauses are inserted in order to apply closer budgetary control and insure the reduction of fees if and when possible. It is preferable to reduce license fee rather than renewal fee.

11. Clause including various councils was added to insure impartiality and to promote uniformity in approval of curricula and institutions, thus tending toward reciprocity. The action and possible cooperation of the three national bodies mentioned has greater probability of agreement than independent approvals by a large number of State Boards. It might obviate charges of prejudice directed against a State Board because of exclusion of an institution elsewhere approved.

12. It may be advisable in some cases to grant the Board authority, with the approval of the Governor, to increase or decrease the fees for certificates and renewals within certain defined limits, in order to keep the Board self-sustaining, and to meet any objection raised that the passage of the Registration Act would tend to increase taxes.

by the chairman and the secretary of the Board under seal of the Board.

The issuance of a certificate of registration by this Board shall be prima facie evidence that the person named therein is entitled to all the rights and privileges of a registered professional engineer, or of a registered land surveyor, while the said certificate remains unrevoked or unexpired.

Each registrant hereunder may upon registration obtain a seal of the design authorized by the Board, bearing the registrant's name and the legend, "Registered Professional Engineer," or "Registered Land Surveyor." Plans, specifications, plats, and reports approved by a registrant shall be stamped with the said seal[13] when filed with public authorities, during the life of the registrant's certificate, but it shall be unlawful for any one to stamp or seal any documents with said seal after the certificate of the registrant named thereon has expired or has been revoked, unless said certificate shall have been renewed or reissued.[13,14]

Section XVI. Expirations and Renewals

Certificates of registration shall expire on the last day of the month of .... following their issuance or renewal and shall become invalid on that date unless renewed. It shall be the duty of the secretary of the Board to notify every person registered under this Act, of the date of the expiration of his certificate and the amount of the fee that shall be required for its renewal for one year; such notice shall be mailed at least one month in advance of the date of the expiration of said certificate. Renewal may be effected at any time during the month of .... by the payment of a fee of $............[15] The failure on the part of any registrant to renew his certificate annually in the month of .... as required above shall not deprive such person of the right of renewal, but the fee to be paid for the renewal of a certificate after the month of .... shall be increased ten per cent for each month or fraction of a month that payment of renewal is delayed; provided, however, that the maximum fee for delayed renewal shall not exceed twice the normal renewal fee.

Section XVII. Practitioners at Time Act Became Effective

At any time within one year after this Act becomes effective, upon due application therefor and the payment of the registration fee of $.......... for professional engineers, or $.......... for land surveyors, the Board shall issue a certificate of registration, without oral or written examination, to any professional engineer or land surveyor who shall submit evidence under oath satisfactory to the Board that he is of good character, has been a resident of the State of .... for at least one year immediately preceding the date of his application, and was practicing professional engineering if an engineer, or land surveying if a surveyor, at the time this Act became effective, and has performed work of a character satisfactory to the Board.

After this Act shall have been in effect one year, the Board shall issue certificates of registration only as provided for in section XII or section XIX thereof.

Section XVIII. Public Work

After the first day of ...., 19...., it shall be unlawful for this State, or for any of its political subdivisions, such as a county, city, town, township, or borough to engage in the construction of any public work involving professional engineering, unless the plans and specifications and estimates have been prepared by, and the construction executed under the direct supervision of, a registered professional engineer; provided that nothing in this section shall be held to apply to any public work wherein the contemplated expenditure for the completed project does not exceed $..........

Section XIX. Reciprocity

The Board may, upon application therefor, and the payment of a fee of $........, issue a certificate of registration as a Professional Engineer to any person who holds a certificate of qualification or registration issued to him by proper authority of the National Council of State Boards of Engineering Examiners, or of the National Bureau of Engineering Registration, or of any State or Territory or Possession of the United States, or of any country, provided that the requirements for the registration of professional engineers under which said certificate of qualification or registration was issued do not conflict with the provisions of this Act and are of a standard not lower than that specified in section XII of this Act.

Section XX. Revocations, Reissuance of Certificates, Appeals

The Board shall have the power to revoke the certificate of registration of any registrant who is found guilty of:

(*a*). The practice of any fraud or deceit in obtaining a certificate of registration;

(*b*). Any gross negligence, incompetency, or misconduct in the practice of professional engineering or land surveying as a registered professional engineer or land surveyor.

Any person may prefer charges of fraud, deceit, gross negligence, incompetency, or misconduct against any registrant. Such charges shall be in writing, and shall be sworn to by the person making them and shall be filed with the secretary of the Board.

All charges, unless dismissed by the Board as unfounded or trivial, shall be heard by the Board within three months after the date on which they shall have been preferred.

The time and place for said hearing shall be fixed by the Board, and a copy of the charges, together with a notice of the time and place of hearing, shall be personally served on or mailed to the last known address of such registrant, at least 30 days before the date fixed for the hearing. At any hearing, the accused registrant shall have the right to appear personally and by counsel, to cross-examine witnesses appearing against him, and to produce evidence and witnesses in his own defense.

If, after such hearing, three or more members of the Board vote in favor of finding the accused guilty, the Board shall revoke the certificate of registration of such registered professional engineer or land surveyor.

Reissuance of certificates: The Board, for reasons it may deem sufficient, may reissue a certificate of registration to any person whose certificate has been revoked, providing three or more members of the Board vote in favor of such reissuance. A new certificate of registration, to replace any certificate revoked, lost, destroyed, or mutilated, may be issued, subject to the rules of the Board, and a charge of $...... shall be made for such issuance.

Appeals: Any person who shall feel aggrieved by any action of the Board in denying or revoking his certificate of registration may appeal therefrom to the ....[16] and, after full hearing, said court shall make such decree sustaining or reversing the action of the Board as to it may seem just and proper.

Section XXI. Violations, Penalties

Any person who shall practice, or offer to practice, professional engineering or land surveying in this State without being registered in accordance with the provisions of this Act, or any person presenting or attempting to use as his own the certificate of registration or the seal of another, or any person who shall give any false or forged evidence of any kind to the Board or to any member thereof in obtaining a certificate of registration, or any person who shall falsely impersonate any other registrant of like or different name, or any person who shall attempt to use an expired or revoked certificate of registration, or any person who shall violate any of the provisions of this Act, shall be guilty of a misdemeanor, and shall, upon conviction, be sentenced to pay a fine of not less than $.........., nor more than $............, or suffer imprisonment for a period not exceeding three months, or both.

It shall be the duty of all duly constituted officers of the law of this State, or any political subdivision thereof, to enforce the provisions of this Act and prosecute any persons violating same. The Attorney General of the State or his assistant shall act as legal adviser of the Board and render such legal assistance as may be necessary in carrying out the provisions of this Act.

Section XXII. Saving Clause*

This Act shall not be construed to prevent or to affect:

(1) *Other professions or trades*

The practice of any other legally recognized profession or trade; or

(2) *Craftsmen*[17]

The activities essential to the normal operation and maintenance of machinery equipment and structures or of craftsmen in the performance of their established functions; or

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13. Certain states have made the use of seals optional, except for filing of plans.

14. It is suggested that the Board regulate the exact method of fulfilling the requirement that plans, specifications, plats, and reports shall be stamped. For example, the Board may rule that every sheet be stamped; or that the title or first sheet only need be stamped; or that only contract documents, or documents of record be stamped; and so on.

15. In States where registrants are few, the annual renewal fee may be $5, but in larger States $1 may be sufficient.

16. Insert name of proper court.

17. This clause has been rewritten and relocated from definitions where it occurs in other drafts.

(3) *Non-residents*
The practice of a person not a resident of and having no established place of business in this State, practicing or offering to practice herein the profession of engineering or land surveying, when such practice does not exceed in the aggregate more than 30 days in any calendar year; provided, such person is legally qualified by registration to practice the said profession in his own State or country in which the requirements and qualifications for obtaining a certificate of registration are not lower than those specified in this Act; or

(4) *Recent arrivals in State*
The practice of a person who has recently become a resident, practicing or offering to practice herein the profession of engineering or land surveying, if he shall have filed with the Board an application for a certificate of registration and shall have paid the fee required by this Act; provided, that such a person is legally qualified by registration to practice said profession in his own State or country in which the requirements and qualifications for obtaining a certificate of registration are not lower than those specified in this Act. Such practice shall continue only for such time as the Board requires for consideration of the application for registration; or

(5) *Employees and subordinates*
The work of an employee or a subordinate of a person holding a certificate of registration under this Act, or an employee of a person practicing lawfully under paragraphs (3) or (4) of this section; provided such work is done under the direct responsibility, checking, and supervision of a person holding a certificate of registration under this Act or a person practicing lawfully under paragraphs (3) or (4) of this section; or

(6) *Government officers and employees*
The practice of officers and employees of the Government of the United States while engaged within this State in the practice of the profession of engineering or land surveying, for said Government; or

(7) *Work as a contractor*
The execution of work by a contractor as distinguished from the planning or design thereof or the supervision of the construction of such work as a foreman or superintendent.[18]

(8) Engineering work of a technical character similar to that of a professional engineer when not for hire to the public and when not in public employment.

Section XXIII. Invalid Sections

If any section or sections of this Act shall be declared unconstitutional or invalid, this shall not invalidate any other sections of this Act.

Section XXIV. Repeal of Conflicting Legislation

All laws or parts of laws in conflict with the provisions of this Act shall be, and the same are hereby, repealed.

18. This clause rewritten and relocated. Its intent here is to permit foremen and superintendents to gain experience within the law and without being required to register. Such experience may lead to qualification credits.

Synthetic Materials as Wire Insulation

WINTON PATNODE E. J. FLYNN J. A. WEH

Preceded by a historical outline of the use of synthetic materials for insulating electric conductors, this article reviews in some detail the use of these materials on magnet wire, with particular reference to the recent introduction of the new insulating coating called "Formex" which is a synthetic resin embodying polyvinyl formal and is applied to wires by the floating die method. Comparative tests show this new material to be markedly superior to former enamel insulating coatings.

DESIGNERS of electrical equipment have shown great skill in making the best use, consistent with safety, of the insulating materials available to them, but the extent of their progress in invention and improvement rests jointly upon the ability of the chemist to provide, and the insulation engineer to apply, better and cheaper insulating materials. The successful commercial production of phenol-formaldehyde resins some 30 years ago provided the electrical industry with a new substance that rapidly found wide use in insulation. Today synthetic molded insulation and insulating varnishes have become indispensable. The development of noncombustible, synthetic liquids, waxes, and resins a decade ago added to the safety and reliability of apparatus insulated with them, and they are today widely used throughout the industry. It is only natural, therefore, that chemists and engineers charged with the improvement of insulation have kept their attention on, and have aided in, the increasingly rapid growth of the synthetic resin industry. The alkyd resins, which today are universally used as finishes, grew out of early researches in the field of electrical insulation, and today chemists in the resin industry still look upon electrical insulation as an important field for synthetic resins.

The literature of electrical insulation is voluminous, scattered, and generally descriptive and technical rather than scientific in nature.[1] The purpose of this article is to describe in general the insulation of wire and cable in the electrical manufacturing industry, with particular emphasis upon the recent introduction of synthetic materials.

In the field of high-voltage transmission cable there is today no large use of synthetic resins, although patent literature discloses numerous suggestions that may be

Essential substance of a paper presented before the paint and varnish division of the American Chemical Society, Baltimore, Md., April 3–7, 1939, and published in *Industrial and Engineering Chemistry*, September 1939, issue.

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1. Reference is made to the following articles (numerals referring to numbered list at end of article) which are typical of a larger list of publications dealing with resinous insulation (12, 60, 40, 16, 70, 71, 72, 31, 39, 53, 48, 42, 68, 69, 37, 24, 33, 64, 65, 18, 19, 20, 1, 11, 46, 36, 45, 7, 8, 26, 38, 17, 25, 23, 3, 5, 47, 6, 10, 35) and to a few monographs (66, 75, 56) which are descriptive of the manufacture and use of electrical insulation. Throughout the remainder of the article, numbered references refer to the list at the end.

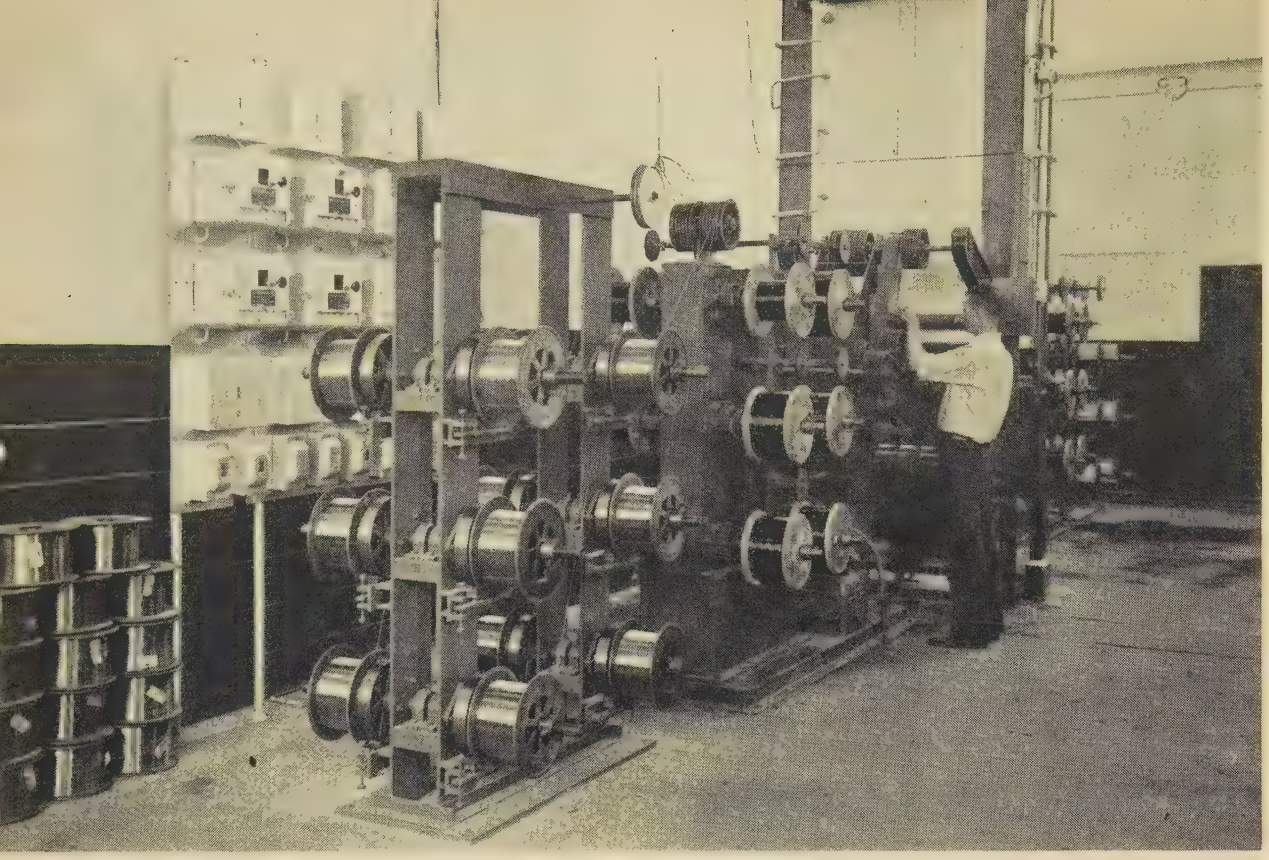

Figure 1. Typical equipment for applying a baked resinous coating to magnet wire

prophetic. Overhead power lines are insulated from ground and from each other by air and by ceramic suspension insulators. Underground lines are insulated with paper and oil enclosed in a lead sheath. The stranded copper conductor is covered by multiple wrappings of paper tape, and the whole is then evacuated and impregnated with mineral oil. It is unlikely that this combination of paper and oil will immediately be replaced by any known synthetic plastic, owing to the very low dielectric loss and high dielectric strength required. Of the materials available today, polymerized hydrocarbons come closest to having the necessary dielectric properties, but they lack the required physical qualifications. Polystyrene has been used, at least experimentally, in insulating cable joints and terminations,[67,59] and as an aid to the study of manufacture and use of high-voltage cables.[74]

The possibility of replacing the paper tape by a synthetic tape is not so remote. Nowak[50] discusses the employment of derivatives of cellulose for this purpose, as do Hagedorn,[32] and Nowak and Hofmeier.[52] The dielectric properties of ethyl cellulose have been measured and reported by Bass and Goggin[4] and Koch.[41] The replacement of the lead sheath by a synthetic plastic sheath is a future possibility in high-voltage cables, since this has already been done on cables of lower voltage. Pallas[54] compares lead and polyacrylates for cable sheathing. In some cables the viscosity characteristic of the impregnating oil is controlled by dissolved resin, but this application for synthetic resins is not of great importance in the technology of cable manufacture.

In the field of medium-voltage transmission, secondary network, and distribution cable, the application of synthetic materials is a little farther along. Cable of this classification is generally insulated with rubber or with multiple wrappings of varnished cloth tape, and is enclosed within a sheath of lead or a pitch-saturated, weatherproof, textile braid. Synthetic resins have been used as ingredients of the varnished cloth for some time, and although certain advantages accrue from their use, this application has not wrought a major change in the cable industry. The rubber has been replaced to a limited extent by synthetic materials having rubber-like physical properties, but improved chemical properties, particularly as regards resistance to oil, ozone, fire, and general long-time deterioration in use. Cable insulation comprising polychloroprene, alkyd resins, plasticized polyvinyl chloride, organic polysulphide condensation products, polyacrylates, polybutadiene, and similar copolymers, as well as derivatives of cellulose and rubber, are generally of composite construction, employing the different materials to best advantage. Stocklin,[62] Badum,[2] and Roelig[57] discuss the use of Buna as cable insulation, and von Rosenberg[58] describes the properties of a number of rubber-like synthetic plastics. Mabb[43] discusses the temperature limitations of insulation comprising cellulose acetate and plasticized polyvinyl chloride. Hamilton[34] and Pallas[55] discuss the application of plastics to the cable industry, and Fuoss[29] describes the preparation of plasticized polyvinyl chloride for measurement of dielectric properties. Nowak and Hofmeier[51] discuss the limiting properties of plasticized polyvinyl chloride as well as copolymers of butadiene, isobutylene, and acrylic esters. These papers are typical of the work now being pushed at a rapid pace abroad, and of the slower domestic trend toward synthetic materials.

In the field of 110–220-volt distribution wiring and of so-called "code wire," there is considerable activity, and synthetic materials have begun to invade the domain of

rubber compound and saturated textile-braid insulation. In this field the mechanical and chemical requirements may be met by a number of synthetic plastics that are suitable from the dielectric standpoint. At the present time much wire is being insulated with plasticized polyvinyl chloride, under the trade name of Flamenol, which is not only oil- and water-resistant, but also will not support combustion. The insulation is rapidly extruded upon the wire, requires no vulcanization, and may be produced in a variety of colors so essential to complex industrial wiring. Development in this field of low-voltage insulation is proceeding rapidly, and the enormous market in building wire should provide an incentive for large-scale low-cost manufacture of materials.

Insulation of Magnet Wire

A complete discussion of the many problems surrounding the introduction of synthetic materials into any one of the foregoing classifications of wire is a long story in itself. In this article only one classification of wire, magnet wire, is discussed in detail. Magnet wire is here defined as insulated wire generally used in the form of coils for the purpose of interchange of electric and magnetic energy. Although seldom seen, magnet wire is all around us; in many of our homes and automobiles, for example, there are from 10 to 20 devices that depend upon a few turns of wire for their operation. The annual production of magnet wire is over 100,000,000 pounds. It is obvious, therefore, that the insulation of magnet wire is of the greatest importance to the electrical industry. It is the one insulation development that is never finished, for, in spite of the many kinds of insulation used and the continual improvement being made in all of them, the perfect magnet-wire insulation is still to be obtained.

Magnet wire is insulated by wrappings of cotton, silk, artificial silk, asbestos, glass, paper, Cellophane, cellulose acetate, continuous films of baked enamel, sometimes pigmented, and combinations of these materials. Numerous attempts have been made to provide the wire with a flexible insulating film of metal oxide. Descriptions of manufacturing processes, and properties of the wire have been published by Greulich,[30] Nowak,[49] Dunton,[21] Wildy,[73] Fleming,[27] Skinner and Chubb,[61] Doht,[14] Dunton and Muir,[22] Frost,[28] Campredon,[9] Manley,[44] Ditmar,[13] Suzuki and Shimizu,[63] and others and in numerous patents. Irrespective of the type of insulation, it must have certain fundamental properties to be of value, namely, flexibility, extensibility, toughness, temperature stability, and adequate dielectric strength in use.

The insulation must be flexible enough to permit the wire to be wound into coils. It must also be extensible, since the wire is stretched slightly even with the most careful hand winding, and a certain amount of stretch cannot be avoided in machine winding. It should be noted also that sudden jerks sometimes break an otherwise extensible insulation.

Toughness is one of the most important requirements of the insulation because in manufacture and use the wire is subjected to incidental abrasion. The best electrical insulation is of no value if it does not have the physical toughness to resist abuse incurred as it is applied to apparatus. A common device for maintaining tension during winding operates by friction of the wire between two solid blocks. The manufacture of some machines requires that the coils of wire be bent or hammered into place. The operation of many machines of which the wire is a part is accompanied by mechanical vibration.

The insulation must be stable and have long life over a considerable range of temperature. Since most apparatus operates at an elevated temperature, the insulation is subjected to temperature cycles ranging from the low of our northern winters to 40 or 50 degrees centigrade above hot summer temperatures.

Adequate dielectric strength is to be expected of the insulation after it is in place in the machine, and under the conditions of use of the machine. This implies operation over the temperature range noted and also during periods of high humidity. Occasional wetting must also be provided for, and coils are frequently impregnated and coated with a waterproof insulation varnish.

These properties are by no means all that are required of magnet-wire insulation. In special cases it must withstand very high temperatures, strong mineral acids and alkalies, refrigerating liquids, tropical climate, steam, salt water, the solvent action of insulating varnishes and in-

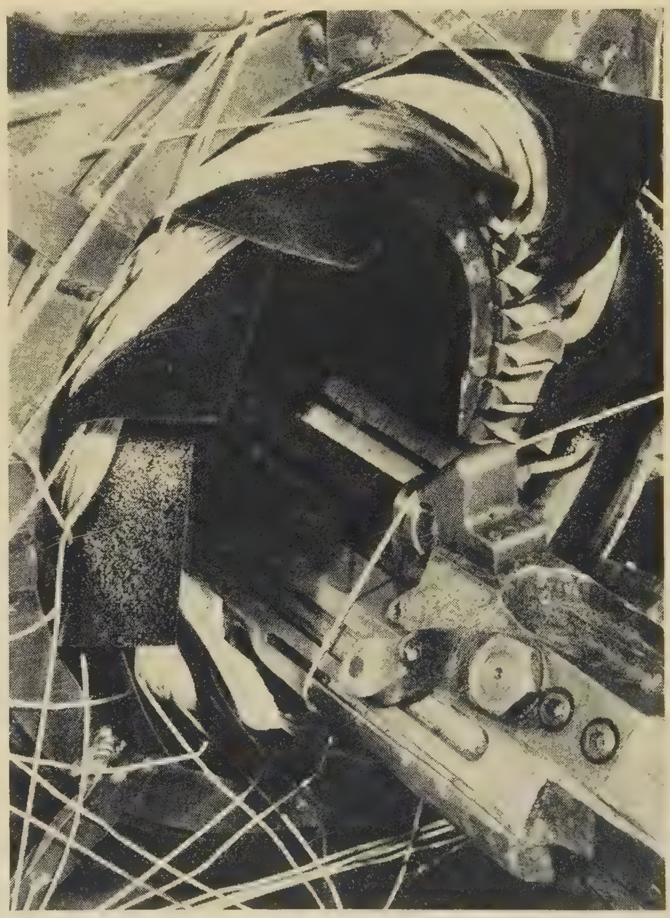

Figure 2. Winding machines such as this not only bend the wire but also stretch it

sulating liquids, iron dust, etc.; in others the dielectric properties must be carefully controlled in order to permit its use in sensitive, tuned, electric circuits.

When considering improvements in magnet-wire insulation, one factor overshadows the others; that factor is the space occupied by the insulation, as provision must be made for this space in the design of machines. As little as 0.001 inch in thickness of the wire insulation, when multiplied by the superposition of turns in a coil, becomes an appreciable volume. The thicker the insulation, the larger the machine; and the cost of the added copper and iron required is often many times the cost of the added insulation. Conversely, sometimes appreciable reductions in the cost of a machine can be made by redesign based upon a reduction of the thickness of the wire insulation. This principle was recognized many years ago, and as early as 1900 attempts were made to replace the bulky textile yarns by thin films of resinous material. One of the first substances applied to wire as a thin film deposited from solution was cellulose acetate, and in 1908 Fleming[27] compared magnet wires insulated with cotton, silk, cellulose acetate, collodion, casein, albumin, and other materials.

Many years ago a thin film of baked drying-oil enamel was found to provide good insulation, and this type of insulation for magnet wire was rapidly developed, until today about 75 per cent of all magnet wire is enameled. The members of the National Electrical Manufacturers Association have agreed upon standard thicknesses of enamel for standard sizes of wire; for the finer sizes, the maximum allowable increase in diameter of the wire is of the order of 0.001 inch or less. In spite of the fact that modern enameled wire is superior to that manufactured in the past, there are many applications where great care must be taken to avoid damaging the film, and much enameled wire is still covered with textile yarn or other wrapping material which provides additional protection.

Consideration of the problem of improving the insulation of magnet wire some years ago, indicated that because of the high dielectric strength and desirable space factor inherent in an enamel film, efforts should be made to improve its mechanical properties. Although minor improvements had been made by the addition of synthetic resins to the oil enamel, major improvements in the physical properties of the film were apparently not to be attained so long as drying oils were the major ingredient. Attention was therefore turned to the production of a wire insulated with a thin film of synthetic resin. After considerable research and development, an insulated wire embodying a thin film of synthetic resin of the polyvinyl acetal type, particularly polyvinyl formal, was produced, which was vastly superior in many respects to wire insulated with conventional enamels.

In undertaking the development of a manufacturing process for magnet wire, there is a choice of methods of manufacture between (1) wrapping a thin film of the resin on wire, (2) extruding the resin directly upon the wire as is done with rubber and other plastic bodies, and (3) coating the wire with a solution of the resin and baking the film by the time-honored process illustrated in figure 1. The first process has the disadvantage of requiring that the ribbon be lapped upon itself in order to get perfect continuity, thus limiting the minimum thickness of insulation that can be applied, to twice the thickness of the ribbon. The practical difficulty and high cost of producing ribbon thin enough to meet the specifications for fine wire makes this process uneconomical except for large wires. The high speed obtainable by the extrusion process is attractive, and this process now is being used for insulating a limited amount of large wire with thick coatings of synthetic materials.

But the extrusion of resin in a uniform, continuous, concentric film in thicknesses of the order of 0.001 inch and less, as required by fine wires, is not easy. Furthermore, with fine wires the high speeds obtainable by the extrusion process are of little advantage, since in the enameling process one man can handle about 100 wires at perhaps 50 feet per minute, making an effective speed per operator of 5,000 feet per minute. The solution process was therefore selected as the most practical method of coating the wire with the polyvinyl formal resin. In the course of the work a further advantage of this process was unexpectedly found when baked films of the resin were discovered to be markedly superior to unbaked films, probably owing to a partial conversion to an insoluble, infusible state.

Solutions of polyvinyl formal resin are very viscous; hence the conventional method of enameling, in which the wire is drawn directly out of the enamel, requires that the resin content of the solution be reduced to a small proportion of the total. Wire can be insulated and has been insulated with polyvinyl acetal type of resins by the conventional method of enameling, but because of the large number of dips and bakes required and the loss of comparatively expensive solvents, improvements in the method were desirable. The well-known processes of applying solutions with the aid of wipers were investigated, and several new wipers were developed, but they were found to be insufficiently stable over long periods of time for the application of the solution uniformly around the wire in accurately measured thickness. The use of rigidly mounted metal dies for applying solutions to wire had been investigated in the General Electric research laboratory many years ago, but because of inherent difficulties had been discarded. It was thus apparent that for practical reasons a new method of applying

Table I. Results of Comparative Tests on Enameled Wire Samples

Sample Number	Increase in Diameter Over Bare Copper	Abrasion Resistance (Number of Turns to Failure): Room Temperature	Abrasion Resistance (Number of Turns to Failure): 105 Degrees Centigrade	Compression Resistance: Average Pressure Required for Failure (Pounds)	Compression Resistance: Average Per Cent Decrease in Thickness
1	0.00245	41	5	790	49
2	0.00165	12	2	960	52
3	0.00290	44	4	1,820	50
4	0.00300	44	8	2,160	50
5	0.00230	46	5	770	38
Formex	0.00285	206	67	5,570	63

very viscous solutions to wire would have to be developed.

The problem was finally solved by the discovery of an entirely new principle of enameling wire—the floating-die principle in which a floating die is maintained concentric with the wire by the wire itself, and applies an accurately measured, concentric, uniform coating of solution around the wire. The usual difficulties experienced in translating any laboratory process to the factory were encountered, and now wire insulated with a film of synthetic resin embodying polyvinyl formal, known by the trademark of Formex, is in large factory production and use.

Comparative Tests on Enamel Coatings

In order to compare Formex wire with other wires insulated with comparable thickness of coating, five samples of number 20 (0.032-inch) heavy enameled wire of different manufacture were purchased on the open market. The National Electrical Manufacturers Association specifications for wire of this size require an increase in diameter from 0.0022 to 0.0030 inch, and the actual increase in diameters of the wires compared is given in table I. These five wires and a Formex wire were examined with the aid of a number of tests designed to evaluate particular properties. These procedures are not standard throughout the industry, but are used by the General Electric laboratories for comparing experimental wires.

The flexibilities of the coatings were compared by observing their behavior when the wires were wound on mandrels of two, five, and ten times the diameter of the wire, at about 40 rpm. The wires were then examined under the microscope, and it was found that none of the samples had cracked during winding.

Extensibility was observed by slowly stretching 100 inches of wire to 110 inches. No cracks were observed in any of the samples. Rapid extensibility was performed by allowing a falling pendulum to act upon a lever which stretched the wire 20 per cent in a fraction of a second. No cracks were observed in the films of any of the wires after this treatment. As mentioned before, winding machines, such as that illustrated in figure 2, not only bend the wire but also stretch it, and in order to observe the effect of an exaggerated treatment of this sort on the six samples of wire, they were all stretched ten per cent in length and then wound on the two-five-ten mandrel. The film on each of the wires except the Formex wire cracked when wound on the mandrel of two times the wire diameter, but not on the others after this treatment. These tests show that enameled wire possesses flexibility and extensibility of a high order, and that control of the amount of stretch given the wire when winding should prevent failures from this source. By comparison, as illustrated in figure 3, Formex wire is in a class by itself.

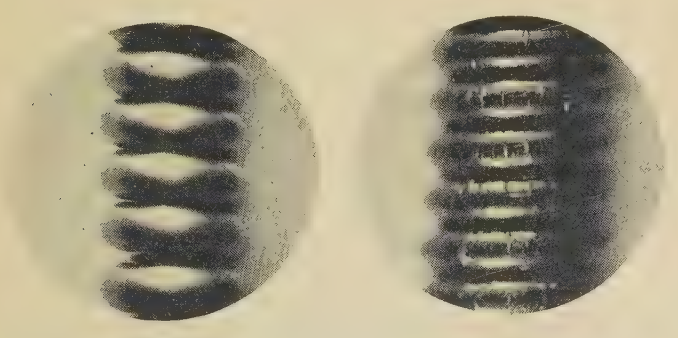

Figure 3. After being stretched at least 20 per cent in length and wound upon its own diameter, the Formex coating showed no signs of cracking (left); the coating of ordinary enameled wire (right) showed severe cracking after having been stretched 10 per cent in length and then wound on a mandrel having twice the diameter of the wire

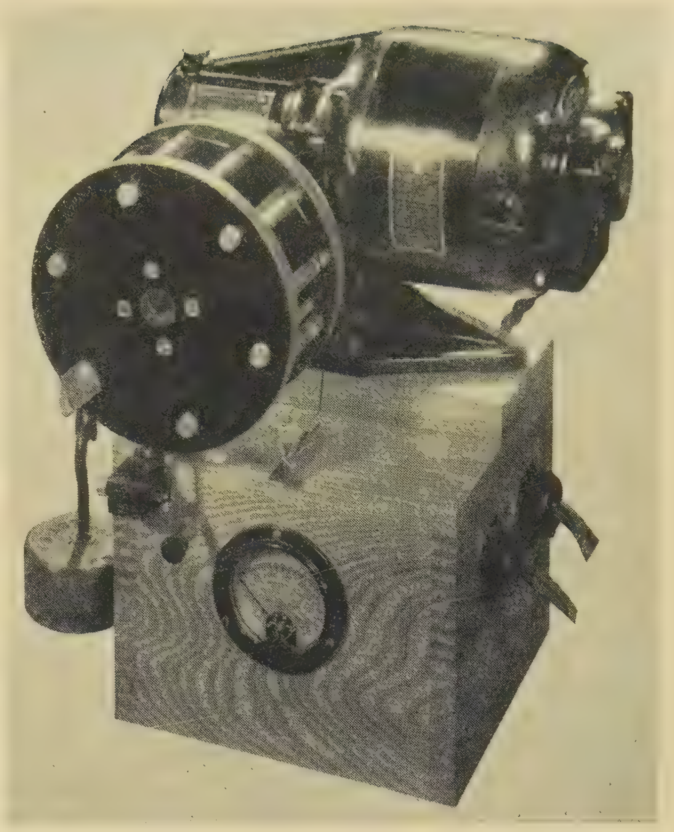

Figure 4. Machine for testing abrasion resistance of enameled wire

In order to compare the resistance of the insulation to abrasion, the six wires were subjected to the abrading action of the machine illustrated in figure 4. One end of the wire to be tested was fastened to the base of the machine, and the other end was brought over the Carboloy spokes of the squirrel-cage drum and was held taut by a weight, thus maintaining a constant pressure of the wire against the spokes. The test consisted in counting the number of revolutions of the drum (which is proportional to the number of rubs given the wire by the Carboloy spokes) required to wear through the film and to produce electrical contact between any one of the rods and the conductor. The results are expressed in number of turns, and the averages of five tests are listed in table I. It may be seen that four of the enameled wires had practically the same abrasion resistance, the fifth is poorer, owing to thinner insulation, and the Formex wire is again in a class by itself.

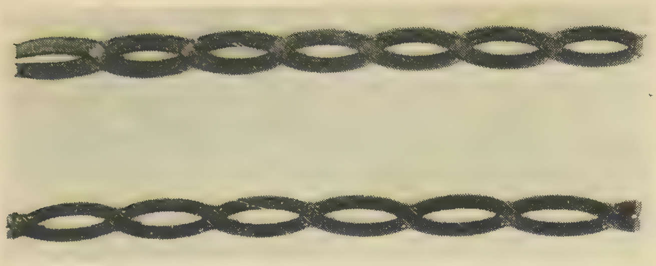

Figure 5. Condition of samples after compression tests, showing the excellent resistance of enameled coatings to compressive stresses

Abrasion and pressure are encountered simultaneously when coils of wire are forced into position in a machine after they have been wound, and a simple test was devised to observe the effect of this operation on the insulation. The wires to be tested were first twisted together into a test piece. Such a twisted pair was then placed between two steel blocks $1^7/_8$ inches long so that seven crossovers were between the blocks. Electrical connection was then made to the wires so that in the event the insulation failed between wires or against either of the steel blocks, a 110-volt lamp was lighted. Pressure was then slowly and uniformly applied to the blocks in a compression testing machine, and the pressure required to rupture the film and complete the electric circuit was recorded. After a failure, the thickness of the flattened portion of the sample was measured, and the per cent change in the thickness of the sample was recorded. Five samples of each wire were so tested. It may be seen from table I and figure 5 that all the wires exhibit excellent resistance to compression, far beyond anything required for ordinary use, and that again the Formex wire is markedly superior to the others.

Tests Simulating Service Conditions

The tests described thus far were designed to compare the effect of mechanical abuse on the insulation, such as is sometimes encountered during assembly of machines. Although they are useful for purposes of comparison, they by no means show that any particular wire can be used successfully in any particular machine. This can be determined only by actual factory trials. Attention now is directed to tests designed to compare the ability of the different insulations to perform their function after they have been wound into the machine.

The purpose of the film on the wire is to insulate the conductor electrically. The quantity and quality of the insulation required depends upon the application, and no single test will serve all applications. However, measurement of dielectric strength is useful, and is generally made. The wires under examination were tested by applying a gradually increasing voltage between two wires twisted together, and recording the voltage at which failure occurred. The samples were tested as received at room temperature and at 105 degrees centigrade, and also after soaking in water overnight (17 hours) at room temperature. The average values of breakdown voltage of five samples are recorded in table II. Note that most of the values for each wire are equally high at room temperature and 105 degrees centigrade, and that, with the exception of sample 2, on which the insulation is thin, the values for the different wires vary only about 30 per cent, which is not greater than the difference between individual samples of the same wire. All the samples lose something by soaking in water, but even this treatment leaves them with sufficiently high dielectric strength for ordinary use. The "annealed" value recorded for Formex wire concerns a property of the film on this wire that is described later in detail. It is well to remember that these tests were made on samples that had been handled very gently, and the values are in no way representative of what might be obtained in practical use.

An illustration of what can happen to enameled wire when it is heated is given in the following test. Samples of the wires were wound on the two-five-ten-diameter mandrel and examined for cracks as in the flexibility test, and none were found. This simulates a winding which appears to be satisfactory by visual examination. The samples were then placed in an oven and heated at 100 degrees centigrade for one-half hour, which simulates the temperature attained by operation of some machines, and again examined, whereupon the coatings of all but the Formex wire and one of the others were found to be badly cracked on the two-diameter mandrel. Now this is an extremely tight turn and would not ordinarily be encountered in winding, so that this is perhaps an unfair test, but it does bring out the fact that mechanical strains set up in the film by winding are sufficient to overcome the tensile strength of the film when hot, and to produce rupture. When samples of the wire were stretched ten per cent in length and then wound, none of them cracked on the five- or ten-diameter mandrel, and all would be considered perfect on visual examination. However, when they were heated to 100 degrees centigrade, all but the Formex wire and one enameled sample showed bad cracks on the five-diameter mandrel, and one cracked on the ten-diameter mandrel. When they were further heated for one-half hour at 150 degrees centigrade, all but the Formex wire cracked on the five-diameter mandrel, and all but the Formex wire and one other cracked on the ten-diameter mandrel. In figure 6 is illustrated Formex wire and the best sample of enameled wire before and after this treatment. This phenomenon appears to be typical of films based on drying-oil enamels, and is one

Table II. Dielectric Breakdown of Enamel Wire Insulation (Kilovolts)

Sample Number	Room Temperature (Dry)	105 Degrees Centigrade (Dry)	Room Temperature (Wet)
1	8.5	5.9	4.4
2	4.1	3.9	2.2
3	9.9	10.5	8.2
4	10.4	10.9	7.8
5	8.9	7.3	5.3
Formex	8.8	7.6	3.2
Formex (annealed)			5.2

that can be very bothersome in difficult windings, requiring that the utmost care be taken in manufacture. Formex wire appears to be immune to this type of failure, as it has never been observed, even in samples stretched more than 20 per cent and then wound on their own diameters.

One of the physical properties that appears to be adversely affected at operating temperatures of apparatus is abrasion resistance. This is important when mechanical vibration from any source sets up vibration of windings and the wires rub together or rub against the confining wall. In order to compare the ability of the wires under examination to resist abrasion at elevated temperature, they were tested on the abrasion machine described, in an oven at 105 degrees centigrade. The average values for five samples are recorded in table I. It may be seen that all the samples are adversely affected, the enamel samples losing from 80 to 90 per cent of their original resistance, and the Formex wire losing two-thirds of its resistance, but in spite of this great loss, it still retains greater resistance to abrasion than the enamel samples had originally.

In any winding there is more or less pressure on the wires under operating conditions owing to expansion and contraction of the parts of the machine. In rotating armatures there is considerable pressure owing to centrifugal force. Although in practice, pressure generally is accompanied by slight vibratory motion and consequent abrasion, it is interesting to observe the flow of the film on the wire at high temperatures in the absence of vibration. For this purpose the device illustrated in figure 7 was employed. Twelve pieces of wire were placed between alternate flat plates as illustrated, so that three inches of

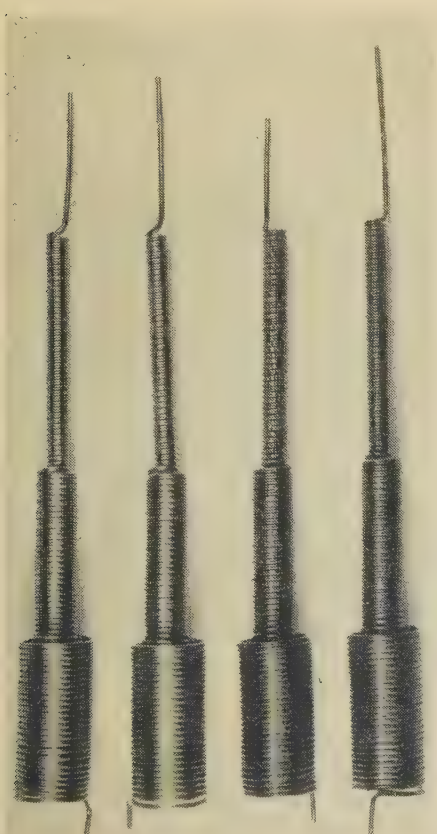

Figure 6. Condition of Formex (left pair) and best enameled samples before (right pair) and after "heat-shock" tests

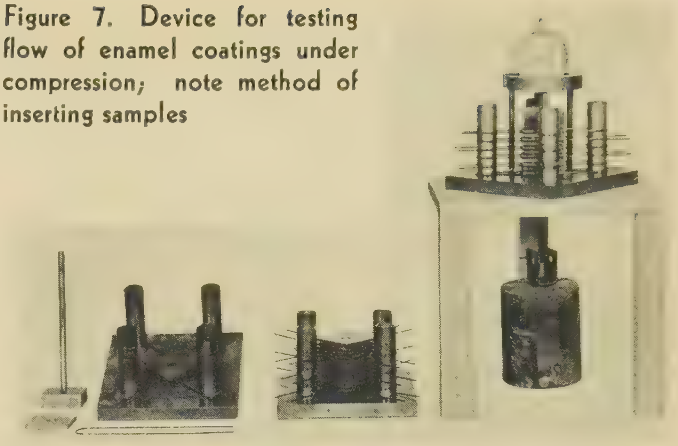

Figure 7. Device for testing flow of enamel coatings under compression; note method of inserting samples

wire was under compression between each pair of plates. The wires were straightened to eliminate kinks and to present a continuous line contact to the pressure of the plate. After the samples were assembled in the apparatus, a weight of ten pounds was suspended from the central suspension as illustrated, and the height of the pile of plates and wires was carefully measured with a dial micrometer. The complete assembly was then heated at 125 degrees centigrade for one hour to allow the flow to take place, and the height of the pile was again measured when cold. From the difference in the two measurements the decrease in thickness of the insulation was determined, and was found to be from 10 to 20 per cent, Formex wire showing the greatest decrease of 20 per cent, and sample 2 the lowest of 10 per cent. The other samples were about the same with a range of 14 to 16 per cent.

The results of this test are of value for purposes of comparison only. No one yet has succeeded in measuring the actual pressures existing between wires in coils in actual service at operating temperatures, and it is doubtful whether such measurements could be made, or that if made whether windings could be duplicated. It should also be pointed out that in service the stress is not always maintained since the wires can move. For rotating armatures, calculations of centrifugal force can be made and pressures estimated, but so far the only reliable test has been actually to test the wire in position in the machine.

Most electrical machinery falls in the classification of durable goods, and must be built to last for years, so a discussion of insulation is not complete without considering the effects of age. Enameled wire behaves in this respect much as would be expected from its composition. The film becomes harder and more brittle with age, and if not bent will provide adequate insulation for many years. However, the film does become brittle, and provision should be made in the design of the machine for protection against incidental blows or bends that would break this brittle film. In order to compare the ability of the various wires under examination to resist this embrittlement, large coils were placed in ovens at 100, 125, and 150 degrees centigrade, and periodically samples were taken and wound upon the two-five-ten diameter mandrel. Although minor differences were found between the different samples of enameled wire, the major difference was be-

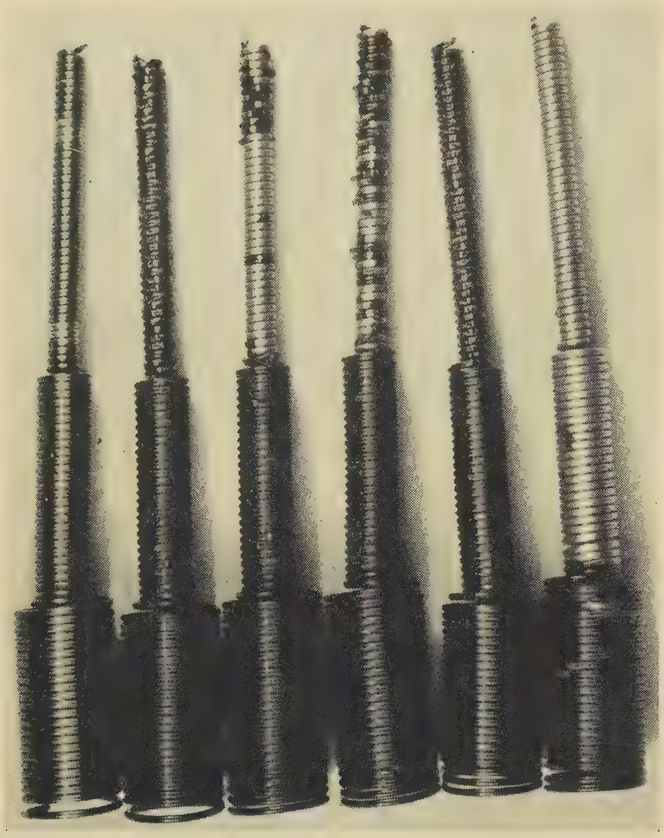

Figure 8. Condition of samples of enameled wire after having been baked at 125 degrees centigrade for 357 hours and then wound on mandrels having two, five, and ten times the diameter of the wire; the Formex sample is at the left. Although not clearly shown here, four of the enameled samples showed cracking in the ten-diameter coils

tween the enamel wire and the Formex wire, as illustrated in figure 8, which shows samples that had been baked at 125 degrees for 357 hours and then wound. Baking at 100 and 150 degrees centigrade brought out the same difference. The film on the Formex wire retained its flexibility four to ten times longer than those of the enameled wires.

Effect of Varnish Solvents

Thus far we have considered some of the properties of magnet-wire insulation that affect the manufacture and use of apparatus, but there is still one manufacturing operation that, unless properly controlled, can do more to nullify all the work and care put into enameling wire than any other, and that is varnish treatment of the apparatus. The varnish treatment of coils originally was adopted to fill the interstices of textile-insulated wire, to bind the turns of the coil together, and to protect it as well as other insulation in the apparatus from moisture. In late years there has been a trend toward waterproofing insulation before it is assembled in the apparatus, and by using good enameled wire, to eliminate the varnish treatment. This by no means has extended to all lines of apparatus, but is an indication of the trend. In apparatus of this type there is one important reason for varnish treatment after winding, and that is to anchor the turns of the coil so that they cannot become loose through vibration. But whatever the reason, the process is usually the same. The coil or apparatus is soaked in varnish, allowed to drain, and then baked to eliminate the varnish solvents and to "cure" the varnish film. To allow the varnish to impregnate deep into a coil, the soaking must be prolonged, or pressure must be applied; and to drive the solvents out of the deep coil, the baking must be prolonged or vacuum used. The detrimental effect of such varnish treatment on the enamel film was recognized many years ago, and has been discussed by several writers including Frost[28] and Greulick.[30] Although modern enameled wire is superior in many respects to the earlier wire, it is still subject to attack by varnish solvents such as petroleum spirits and coal tar naphtha.

In order to observe the action of varnish solvents on the wires under examination, the following procedure was carried out. Samples of each of the wires were straightened and immersed for a period of three hours at room temperature in (1) petroleum spirits, (2) high-flash naphtha, (3) butanol, and (4) a mixture of equal parts of butanol and high-flash naphtha. The effect on the film was observed by removing each sample from the liquid and immediately subjecting it to controlled abrasion. This was accomplished by drawing the wire under constant pressure at right angles to, and over, a steel wire of 0.010-inch diameter. The pressure on the wire was previously adjusted to a value such that the film of enamel was not damaged when thus abraded before soaking in the solvents. When the soaked samples were so tested, it was found that all of them except the Formex wire were softened enough so that more or less of the film was scraped off (see figure 9). Petroleum spirits had the least effect, and the mixture of butanol and high-flash naphtha, the greatest.

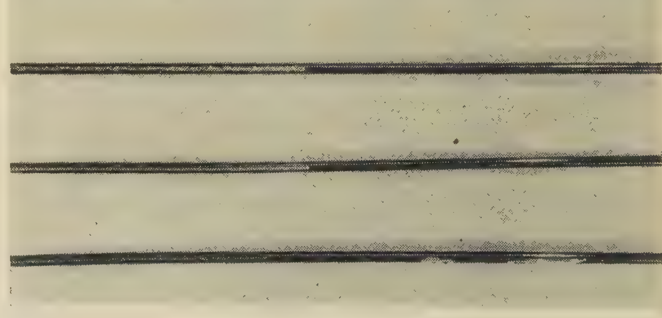

Figure 9. Condition of test samples after having been immersed for three hours at room temperature in a mixture of butanol and high-flash naphtha, and then subjected to an abrasion test (Formex sample at top)

In connection with this test, a phenomenon may be observed that apparently is of importance only with Formex wire. Although the film is not greatly softened by immersion in the commonly used solvents, it is affected under certain conditions in a totally different way. When a sample of Formex wire is bent at room temperature and then immersed in high-flash naphtha, there immediately appears upon the surface of the wire a multitude of fine hairline cracks that may be seen under the microscope. This phenomenon is not specific to high-flash naphtha, but has been observed in connection with many other liquids. If, however, the wire has not been bent, the cracks do not appear. Apparently the stresses produced in the film by bending the wire are great enough to exceed the tensile strength of the material when wet with certain liquids, and in some respects this phenomenon resembles the cracking produced by heat in stressed enamel coatings or that produced by ozone in stressed rubber. It differs from the cracking of enamel and rubber in that the strain decays very rapidly at high temperature, and is consequently easily avoided. This can be accomplished by heating the wire to a sufficiently high temperature and for a long enough time to allow the strain to decay internally, and generally a few minutes at 80 degrees centigrade or above is sufficient (see figure 10). If time enough is allowed, the strains will decay at room temperature, although generally room temperature (25 degrees centigrade) is not high enough to reduce the time much below two weeks.

This heat treatment after winding and before varnish treatment is not necessary if the proper varnish treatment is employed, since the cracks disappear when the varnish is baked. This is not entirely due to filling the cracks with varnish resin, since the phenomenon takes place in the absence of resin. Samples of stressed Formex were dipped in the solvents mentioned, thereby developing surface cracks. They were allowed to dry in the air, and were then baked at 150 degrees centigrade for one-half hour. This treatment resulted in the disappearance of the cracks and the formation of the original smooth glossy surface. The phenomenon of healing by baking has been observed with three commercial insulating varnishes, as well as with solvents, and appears to be general.

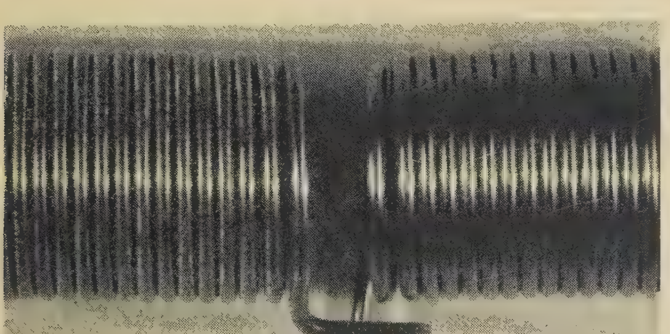

Figure 10. Soaking in high-flash naphtha caused fine surface cracks to appear in the surface of Formex wire (left); these cracks did not appear when the wire (right) previously had been heated for three minutes at 80 degrees centigrade and then soaked in the same liquid

The phenomenon has been studied in relation to the dielectric strength of the insulation. The difference between the dielectric breakdowns for the annealed sample of Formex wire and that for the unannealed sample listed in table II, is probably due to superficial cracking of the surface of the film by water, although the cracks are not visible under the microscope, and water vapor does not produce the same result as liquid water.

When coils were treated with a commercial insulating varnish thinned with benzene and alcohol, the superficial cracks appeared, and were still visible under the microscope after baking at 70 degrees centigrade to evaporate the solvents. The dielectric strength of the insulation, however, even in the presence of these superficial cracks was as high as that of the untreated wire, and after baking at 150 degrees centigrade to cure the resin, the dielectric strength was still higher.

Laboratory tests, such as these described here, give a comprehensive picture of the properties of magnet wire, but must be correlated with factory and field experience in order to judge the importance of each property measured, In the case of enameled wire, we have over 30 years of successful application experience, and have learned how to use it within its limitations. In the case of Formex wire we have properties that are distinctly superior to enamel, which permit changes in manufacturing procedure and redesign of apparatus. In the space of time that Formex wire has been used, some half million pieces of equipment have been wound with it, in some cases as a substitute for enameled wire, or cotton-covered wire; in others, apparatus has been redesigned to take advantage of its superior properties. One of the most interesting examples of its use is in hermetically sealed refrigerator units using the refrigerant known as Freon *F*-12. In this instance it is taking the place of wire previously insulated with more than five times its thickness of cotton.

It is still too soon to say to what extent Formex wire will replace conventional enameled wire. It has been found useful in a wide variety of applications, has permitted advances in manufacturing technique and in the construction of apparatus not hitherto practical, and its use is being extended as rapidly as technical and economic considerations allow. But whatever the outcome, manufacturing and field experience has been so uniformly good that synthetic materials will certainly play an increasingly important part in the field of wire insulation.

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News

Of Institute and Related Activities

Middle Eastern District Meeting in Scranton, Pa., October 11–13

ARRANGEMENTS are being completed for the AIEE Middle Eastern District meeting and Student Branch convention to be held in Scranton, Pa., October 11–13. Headquarters for the meeting will be at Hotel Casey. The local committees have arranged an attractive and diversified technical program of five morning and afternoon sessions. A testimonial luncheon in honor of Doctor C. F. Scott, AIEE past-president and founder of Student Branches, is being sponsored by the Branches, and separate meetings of Branch counselors and Branch chairmen have been arranged. Among interesting inspection trips scheduled is one through anthracite-coal mines. Entertainment and social gatherings have been arranged for the evenings, with a special program for women guests, who are urged to attend the meeting.

Host for the District meeting is the Lehigh Valley Section, which comprises northeastern Pennsylvania and a small section of New Jersey. Scranton, selected by the Section as host city, is situated in the heart of the anthracite-coal region, surrounded by the picturesque Moosic mountains of the Appalachian range. Called "the electric city," it is the third largest city in Pennsylvania, with a population of 145,000 and a local trade density of 300,000, and is easily accessible by train or car from all parts of the District, being served by four railroads and two major highways. Besides being the metropolis of the anthracite-coal industry, the city has other diversified industries, including silk, moulded products, and textiles, and contains the home office of the International Correspondence Schools, largest institution of the kind in the world.

Program for Women Guests

Wednesday, October 11

Morning	Registration, Hotel Casey
1:00 p.m.	Luncheon, The Scranton Club
2:00 p.m.	Reading and musical program, The Scranton Club
8:30 p.m.	Informal get-together and entertainment (details at Registration Desk)

Thursday, October 12

9:30 a.m.	Leave headquarters hotel for The Scranton Country Club—golf, tennis, games, bridge
12:30 p.m.	Luncheon, The Scranton Country Club
2:00 p.m.	Scenic tour (on return trip will stop at The Scranton Country Club; details will be announced.)
6:30 p.m.	Informal dinner and dance, Hotel Casey

Friday, October 13

This day has been purposely left open in the belief that some of the women guests would like to join their husbands in the inspection trip to the Marvine anthracite coal mines (see schedule).

Inspection Trips

Six inspection trips, three on Wednesday, October 11, and three on Friday, October 13, have been arranged. To assist the committee in planning transportation, members are requested to make definite arrangements at the registration desk, where they will find a schedule of the times at which trips leave from headquarters. The following trips have been planned:

Wednesday, October 11

1. *Marvine anthracite-coal mines of the Hudson Coal Company.* The trip through the mines includes inspection of the company's immense underground pumping project. Inasmuch as operations at this mine involve handling an average of some 27 tons of water for each ton of coal shipped to market, pumping constitutes a very important problem. As an indication of the equipment involved, it is noteworthy that eight pumps, aggregating 32,000 gallons per minute in capacity and driven by a total of 3,200 horsepower in 25-cycle motors, occupy one underground gallery 181 feet long, 22 feet wide, and 30 feet high, while related switchboard and control equipment occupies an adjacent gallery 40 by 12 by 17 feet in size. This trip will be repeated on Friday.

2. *International Correspondence Schools, Scranton.* Largest correspondence school in the world.

3. *Wallenpaupack hydroelectric plant of the Pennsylvania Power and Light Company, Hawley, Pa.* This station has a capacity of 40,000 kw, in two 20,000-kw units. The reservoir, when full, forms a lake 13 miles long and a mile wide, containing 7,400,000 cubic feet of water. The pipe-line from lake to generating plant is 3.5 miles long and 14 feet in diameter. This trip includes a drive of about 35 miles through the woodlands of northeastern Pennsylvania.

Friday, October 13

1. *Hazard insulated-wire works of the Okonite Company, Wilkes-Barre, Pa.* Members will be welcomed by the staff of the company and conducted through the plant.

2. *Stanton steam plant.* Located about 4 miles above Pittston on the Susquehanna River and about 15 miles from Scranton, the Stanton plant, capacity 100,000 kw, is the largest plant in this section of the country burning anthracite coal to generate electricity. Members of the staff will conduct a tour of the entire plant, from the point at which anthracite coal is unloaded, a car at an operation, from the railroad's gondola, to the boiler plant where it is transformed into steam, the steam generators, and the electrical switchyard.

3. *Marvine anthracite-coal mines of the Hudson Coal Company.* Same as Wednesday trip.

Entertainment and Sports

A stag smoker will be held on Wednesday evening at the Hotel Casey. Diversified entertainment will be followed by a buffet supper. Tickets $1.00.

On Thursday, October 12, an informal dinner will be served at 6:30 p.m. at Hotel Casey. Talks will be given by national and District officers and by a guest speaker, after which there will be dancing; tickets $1.50 per person.

Arrangements have been made with the Scranton Country Club for golf, and the Scranton Tennis Club for tennis. Those desiring to play golf should make inquiry at the registration desk Wednesday morning, and watch for announcements by the committee in charge.

Women's Program

A special invitation is extended to women to attend the District meeting with their husbands. Particular attention has been given to the program of activities (see accompanying schedule). To assist the committee in arranging for transportation and luncheons, guests are requested to register

Hotel Rates in Scranton, Pa.

Hotel	Location	Single Rooms: Running Water	Single Rooms: Bath	Double Rooms: Running Water	Double Rooms: Bath
Casey*	Lackawanna and Adams Avenues	$2.50	$3.00–5.00	$4.00	$5.00–8.00†
Jermyn	Wyoming Avenue and Spruce Street	2.00, 2.50	2.50–3.50	3.00, 3.50	4.00–6.00
Marquette	416 Adams Avenue	1.25, 1.50	2.00	2.00, 2.50	3.00
Holland	408 Adams Avenue	1.50	2.00	2.00, 2.50†	3.00, 3.50†
YMCA#	Washington Avenue and Mulberry Street	1.25	1.50		

* Meeting headquarters. Suites are available at Hotel Casey at $7.50–10.00 for single occupancy; $9.00–12.00 for double occupancy. Some can accommodate from four to eight people, at $1.50 daily per person for each additional occupant.

† Some double rooms with twin beds.

Rooms without running water: single $1.00; double $1.50.

In all cases, individual guests occupying double room with bath will be charged full double-room rate.

for attendance at the events on the program at least three hours before time scheduled.

Hotels and Registration

Members should make room reservations by writing directly to the hotel of their preference. Rates at the headquarters hotel and others are listed in the accompanying table. All the hotels listed are within four or five blocks of the headquarters hotel.

Members of the District who plan to attend the meeting should register in advance by returning the addressed advance-registration card which they will receive by mail. This will be helpful to the registration committee, permit badges to be prepared in advance, and reduce the work necessary on the opening day. A minimum registration fee of $2.00 will be charged all nonmembers except Enrolled Students and the immediate families of members.

Committees

District meeting: I. Melville Stein, H. A. Dambly, E. F. DeTurk, A. G. Ennis, W. A. Furst, J. W. Mills, H. S. Phelps, J. E. Treweek, E. F. Weaver.

General: E. F. DeTurk, *chairman;* J. L. Beaver, J. G. Charest, N. S. Hibshman, W. H. Lesser, J. W. Mills, G. E. Northup, M. O'Toole, and E. F. Weaver.

Meetings and papers: J. G. Charest, *chairman;* E. Bell, G. M. Keenan, W. J. Kistler, J. W. Mills.

Student activities: N. S. Hibshman, *chairman;* W. H. Formhals, G. A. Irland, E. E. Kimberly, F. W. Smith, W. M. Young.

Inspection and transportation: W. H. Lesser, *chairman;* R. C. Cox, W. J. D. Geary, L. H. James, F. W. Jennings, C. H. McKnight.

Hotels and registration: J. W. Mills, *chairman;* D. J. Connell, F. C. Pethick, W. A. Thomas.

Publicity and attendance: G. E. Northup, *chairman;* W. A. Everson, W. H. Formhals, W. J. Kistler, P. Markarian, R. Moore, A. B. Platt, J. A. Strelzoff, P. A. Weaver.

Entertainment: M. O'Toole, *chairman;* W. E. Connor, R. C. Cox, W. J. D. Geary, G. E. Northup, W. Seiple.

Finance: E. F. Weaver, *chairman;* O. A. Griesmer, W. H. Lesser, J. E. Treweek.

Ladies: Mrs. G. E. Northup, *chairman;* Mrs. J. G. Charest, Mrs. A. B. Platt, Mrs. J. A. Strelzoff, Mrs. E. F. Weaver.

Tentative Program

Advance copies of papers will be made available as papers are approved. If ordered by mail, price ten cents per copy; if purchased at Institute headquarters or at the meeting, price five cents per copy. The announcement of the meeting to be sent to members within the District and nearby territory will carry an order form for those who wish to order advance copies of papers.

Discussions to be considered for publication should be typewritten (double-spaced) and submitted in triplicate to C. S. Rich, secretary, technical program committee, AIEE headquarters, 33 West 39th Street, New York, N. Y., on or before October 27, 1939. Discussion of informal addresses and papers need not be submitted.

Wednesday, October 11

9:00 a.m. Registration

10:30 a.m. Mining

Application of Power in the Anthracite Coal Industry. **W. H. Lesser,** Pierce Management

Mercury Arc Rectifiers in the Coal Mining Industry. **D. H. Renshaw,** Westinghouse Electric and Manufacturing Company

New Type Mine Locomotive. **H. F. Flowers,** Differential Steel Car Company

Formal meeting of AIEE standards co-ordinating committee 4

2:00 p.m. Standards

Operating Conditions Affecting Electrical Apparatus Met With in the Steel Industry. **G. A. Caldwell,** Westinghouse Electric and Manufacturing Company

Application of Class B Insulation to Direct Current Motors in Heavy Duty Service. **F. A. Compton, Jr.,** General Electric Company

Guide For Selection of Distribution Transformer Size as Determined by Load Cycle Requirements. **M. F. Beavers,** General Electric Company

Temperature Rise of Electrical Apparatus as Affected by Radiation. **G. W. Penney,** Westinghouse Electric and Manufacturing Company

Résumé of Work of the Standards Committee on Revising AIEE Standard No. 1. **P. L. Alger,** chairman, AIEE co-ordinating committee 4

Afternoon. Inspection trips

8:30 p.m. Stag smoker

Thursday, October 12

9:30 a.m. Power Transmission and Distribution

Power Supply for Suburban Areas. **R. A. Hentz** and **J. A. Thielman,** Philadelphia Electric Company

Protector Tubes for Power Systems. **H. A. Peterson** and **W. J. Rudge,** General Electric Company, and **A. C. Monteith** and **L. R. Ludwig,** Westinghouse Electric and Manufacturing Company

Lightning Investigation on a 220-Kv System III. **Edgar Bell,** Pennsylvania Power and Light Company

Some Recent Developments in Impulse Voltage Testing. **C. M. Foust** and **N. Rohats,** General Electric Company

9:30 a.m. Student Branch Counselors' Conference

Professor E. E. Kimberly, Ohio State University, chairman Student Branch activities, District 2, presiding

9:30 a.m. Student Branch Officers and Delegates Conference

W. M. Piatt, Lafayette '40, chairman
R. B. Schnure, Bucknell '40, secretary

12:00 m. Testimonial Luncheon

Sponsored by the Student Branches in honor of **Doctor Charles F. Scott,** past-president AIEE, and founder of the Student Branches of the Institute.

A. S. Mickley, Lehigh '40, presiding

Professor F. C. Caldwell, Ohio State University

Doctor Charles F. Scott

Dean William M. Young, Ohio University

2:30 p.m. Meters, Relays, and Protection

New Developments in Current Transformer Design. **G. Camilli,** General Electric Company

Carrier Current Control. **A. M. Trogner,** Line Material Company

Distribution Line Sectionalizing. **R. E. Neidig,** Metropolitan Edison Company

Oilless Circuit Breakers. **D. C. Prince,** General Electric Company

6:30 p.m. Dinner (strictly informal)

Elmer F. DeTurk, toastmaster

Speakers (reserved as a surprise)

9:30 p.m. Dancing

Friday, October 13

9:30 a.m. Electrical Apparatus

Trends in High-Voltage Porcelain Bushing Development. **T. F. Brandt,** Ohio Brass Company

Transformer Protection and Operation. **J. B. Hodtum,** Allis-Chalmers Manufacturing Company

Adjustable Speed A-C Motor. **Howard W. Edmunds,** Crocker-Wheeler Electric Manufacturing Company

Theory and Design of NEMA Resistors for Motor Starting and Speed Control. **G. C. Armstrong,** Westinghouse Electric and Manufacturing Company

Afternoon. Inspection Trips

Lamme Medal Nominations Due December 1

Attention is called again to the opportunity open to any member of the Institute to submit nominations for the 1939 AIEE Lamme Medal. All nominations must be received not later than December 1 (for further particulars, see Electrical Engineering for June 1939, page 265). The 1938 Lamme Medal was awarded to Marion A. Savage, designing engineer, General Electric Company, Schenectady, N. Y.

ASME and Cornell Honor Thurston

The hundredth anniversary of the birth of Robert Henry Thurston, pioneer in engineering education and first president of the American Society of Mechanical Engineers, will be celebrated by Cornell University and the ASME with ceremonies at Ithaca, N. Y., October 25, 1939. The day's program will include an academic procession, memorial ceremony, and an exhibit of Thurston's publications and laboratory apparatus. Delegates from American and Canadian engineering schools and from technical and academic societies, and alumni of Stevens Institute of Technology and Cornell University from the classes of Thurston's time, have been invited to participate in the celebration.

Great Lakes District Meeting in Minneapolis, Minn., September 27–29

THE AIEE Great Lakes District extends a cordial invitation to attend the meeting in Minneapolis, September 27–29, 1939. Headquarters will be in the Hotel Nicollet. An excellent technical program, supplemented by interesting inspection trips and entertainment, is offered for members, their families, and friends of the Institute. Student members will find a special program arranged for them, with members of their own group offering papers for discussion.

During the period of the meeting the District executive committee and the District committee on student activities will hold their respective annual business meeting and conference.

Entertainment and Sports

A variety of entertainment, including a luncheon, sightseeing tours, and dinners has been arranged for the meeting. On Wednesday, September 27, a joint luncheon with the Minneapolis Engineers Club and the St. Paul Engineers Society will be held at the Hotel Nicollet, tickets 85 cents each. In the afternoon a sightseeing tour through Minneapolis, St. Paul, and the vicinity is planned, tickets $1.25 each. At 7 p.m. a dinner will be held at the Minneapolis Automobile Club, tickets $1.50 each.

On Thursday afternoon arrangements will be made to visit the new modern hydraulic laboratory of the University of Minnesota, tickets 25 cents each. In the evening at 7 o'clock a dinner dance will be held at the Hotel Nicollet—tickets $2.00 each. The gathering will be addressed by Doctor Phillips Thomas.

On Friday, September 29, opportunity will be given to visit any of the industrial, educational, and scenic points of interest in and around the Twin Cities, such as: The Electric Machinery Company, The Minneapolis - Honeywell Heat Regulator Company, the University of Minnesota, the generating plants of the Northern States Power Company, the Minnesota Mining and Manufacturing Company, Fort Snelling, Mendota, and others, tickets 50 cents each. Booklets containing tickets for all the trips mentioned will be available at the registration desk for $5.00.

No golf tournament has been scheduled, but arrangements to play on the University of Minnesota course, or on any of the beautiful public or private courses in the Twin Cities will be made by the entertainment committee upon request.

On Saturday, September 30, the famous "Golden Gopher" football team plays the University of Arizona team. This is the first game of the 1939 season. Tickets are $2.20 or $1.10 per seat, depending upon location. Reservations may be made directly with the football ticket manager, University of Minnesota, Minneapolis.

Program for Women Guests

Wednesday, September 27

Morning	Registration
Noon	Visit and uncheon, Minneapolis Art Institute. Tickets 75 cents each
Afternoon	Sightseeing trip, for members, their families, and guests
Evening	Dinner at Minneapolis Automobile Club, Bloomington-on-the-Minnesota

Thursday, September 28

Morning	Leave Nicollet Hotel for trip to Stillwater, Minnesota. Luncheon and cards at Lowell Inn, returning to Minneapolis about 3 p.m. Luncheon tickets, 85 cents each
Evening	Dinner-Dance at Hotel Nicollet

Friday, September 29

Open for sightseeing trips and other entertainment to be announced on first day of meeting.

Women guests who desire to play golf will find numerous excellent courses, both public and private, at their disposal. Necessary arrangements will be made upon request to the entertainment committee.

Student Branch Convention

A technical session and a business session have been planned specifically for student members. All trips and entertainment features of the program are open to students. For further information student members should contact Professor J. H. Kuhlmann, counselor of the University of Minnesota Branch, at the electrical-engineering department, University of Minnesota, Minneapolis.

Hotels and Registration

Members should make room reservations by writing directly to the hotel of their preference. For convenience the rates of the headquarters hotel, Hotel Nicollet, as well as the rates of other hotels are listed in the accompanying table.

Members of the District who plan to attend the meeting should register in advance by returning the addressed, advance-registration card which they will receive by mail. This will be helpful to the registration committee, permit badges to be prepared in advance, and reduce the work necessary on the opening day. A minimum registration fee of $2.00 will be charged all nonmembers except Enrolled Students and the immediate families of members.

Committees

District Meeting: A. H. Lovell, District vice-president; A. G. Dewars, District secretary;

Hotel Rates in Minneapolis, Minn.

Hotels	Location	Without Bath		With Bath	
		Single	Double	Single	Double
Nicollet*	Nicollet at Washington			$3.00 up	$4.50 up
Andrews	Hennepin at Fourth Street	$1.50 up	$2.50 up	2.50 up	3.50 up
Curtis	Tenth at Fourth Avenue South			2.00 up	3.00 up
Dyckman	27 South Sixth Street			2.00 up	3.00 up
Leamington	Tenth at Third Avenue South			2.50 up	3.50 up
Radisson	45 South Seventh Street	2.00 up	3.50 up	3.00 up	4.50 up

* Meeting headquarters

Tentative Program

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Wednesday, September 27

8:00 a.m. Registration, mezzanine floor

9:30 a.m. General Meeting

Announcements: **A. H. Lovell**, vice-president, Great Lakes District, AIEE

Address of Welcome: Governor Harold E. Stassen

10:15 a.m. Communication and Research

LOAD-RATING THEORY FOR MULTICHANNEL AMPLIFIERS. **B. D. Holbrook** and **J. T. Dixon**, Bell Telephone Laboratories, Inc.

EMERGENCY RADIO IN THE TELEPHONE BUSINESS. **R. E. Willey**, Northwestern Bell Telephone Company

IMPORTANCE OF GAS IN ELECTRODES FOR THE GLOW-TO-ARC TRANSITION. **F. A. Maxfield**, **H. R. Hegbar**, and **J. R. Eaton**, The University of Wisconsin

CAUSES OF CORROSION OF FINE COPPER WIRES CARRYING A POTENTIAL. **H. N. Stephens** and **G. B. Gehrenbeck**, Minnesota Mining and Manufacturing Company

10:15 a.m. Electrical Machinery and Transportation

DYNAMIC CHARACTERISTICS OF A SINGLE-PHASE INDUCTION MOTOR. **E. B. Kurtz**, University of Iowa

CO-ORDINATION OF THE CONTROL OF SYNCHRONOUS-MACHINE EXCITATION. **L. L. Fountain**, Westinghouse Electric and Manufacturing Company, **E. F. Dissmeyer** and **J. A. Elzi**, Commonwealth and Southern Corporation

POLARIZED FIELD FREQUENCY CONTROL OF SYNCHRONOUS MOTORS. **E. W. Swanson**, Electric Machinery Manufacturing Company

MODERNIZATION OF A TRANSIT SYSTEM, FACTORS THAT DETERMINE THE CHOICE OF VEHICLE. **George L. Hoard**, University of Washington

12:15 p.m. Joint Luncheon With Minneapolis Engineers Club and St. Paul Engineers Society

2:30 p.m. Tour of Minneapolis, St. Paul, and vicinity

7:00 p.m. Dinner at the Country House of the Automobile Club of Minneapolis at Bloomington-on-the-Minnesota

Thursday, September 28

9:30 a.m. Selected Subjects and Measurements

AN UNSTABLE NONLINEAR CIRCUIT. **C. M. Summers**, General Electric Company

PROTECTOR TUBES FOR POWER SYSTEMS. **H. A. Peterson** and **W. J. Rudge**, General Electric Company, and **A. C. Monteith** and **L. R. Ludwig**, Westinghouse Electric and Manufacturing Company

SOME RECENT DEVELOPMENTS IN IMPULSE-VOLTAGE TESTING. **C. M. Foust** and **N. Rohats**, General Electric Company

ELECTRONIC MEASUREMENT OF SURGE-CREST VOLTAGES. **J. M. Bryant** and **M. Newman**, University of Minnesota

MEASUREMENT OF VERY SHORT TIME LAGS. **J .M. Bryant** and **M. Newman**, University of Minnesota

9:30 a.m. Student Session

Papers from members of the Student Branches in the Great Lakes District area will be presented

12:15 p.m. Luncheon, Hotel Nicollet

1:30 p.m. Business Session: Great Lakes District Committee on Student Activities

Chairman Ben S. Willis, Iowa State College, presiding

3:30 p.m. Inspection Trip to Hydraulic Laboratory, University of Minnesota

7:00 p.m. Dinner, Hotel Nicollet

Address, "Developments in Research," accompanied by demonstrations, by **Doctor Phillips Thomas**, research engineer, Westinghouse Electric and Manufacturing Company

Dancing

Friday, September 29

9:30 a.m. Power Transmission and Distribution

RATIO-DIFFERENTIAL PROTECTION OF TRANSMISSION LINES. **R. M. Smith** and **M. A. Bostwick**, Westinghouse Electric and Manufacturing Company

ARC-FURNACE LOADS ON LONG TRANSMISSION LINES. **T. G. LeClair**, Commonwealth Edison Company

ANALYSIS OF FACTORS WHICH INFLUENCE THE APPLICATION, OPERATION, AND DESIGN OF SHUNT-CAPACITOR EQUIPMENTS SWITCHED IN LARGE BANKS. **J. W. Butler**, General Electric Company

CYCLIC LOADING OF SUBWAY-TYPE DISTRIBUTION TRANSFORMER. **O. W. Muckenhirn**, University of Minnesota, and **H. G. Zambell**, Allis-Chalmers Manufacturing Company

VAULTS FOR A-C SECONDARY NETWORKS. **J. S. Parsons**, Westinghouse Electric and Manufacturing Company

12:15 p.m. Luncheon

1:30 p.m. Inspection Trips

1:30 p.m. Annual Meeting of Executive Committee, Great Lakes District

Vice-President A. H. Lovell, presiding

H. W. Anderson, J. H. Bowman, J. H. Bryant, R. E. Burlingame, J. A. Fitts, E. H. Hagensick, C. H. Nelson.

General: C. H. Nelson, *chairman;* R. E. Burlingame, J. M. Bryant, A. G. Dewars, J. B. Garthus, E. H. Hagensick, Truman Hibbard, J. H Kuhlmann, H. W. Meyer, Mrs. H. W. Meyer.

Meetings and papers: I. B. Garthus, *chairman;* P. G. Bowman, E. N. Clark, W. H. Gille, H. E. Hartig, C. C. Nelson.

Entertainment: H. W. Meyer, *chairman;* Andrew Nelson, M. E. Todd.

Transportation and inspection: E. G. Hagensick, *chairman*; J. M. Bryant, R. R. Herrmann.

Finance: Truman Hibbard, *chairman;* R. F. Pack, H. J. Pierce.

Publicity: A. G. Dewars, *chairman;* Oscar Gaarden, E. W. Johnson.

Student sessions: J. H. Kuhlmann, *chairman;* O. W. Muckenhirn, H. A. Sanderson.

Hotels and registration: R. E. Burlingame, *chairman;* W. Endicott, W. C. Walsh.

Women's entertainment: Mrs. H. W. Meyer, *chairman;* Mrs. J. H. Kuhlmann, Mrs. Andrew Nelson, Mrs. C. H. Nelson, Mrs. M. E. Todd.

Connecticut Section to Honor Charles F. Scott

For the first meeting of the year 1939–40, the AIEE Connecticut Section will hold a testimonial dinner to Charles Felton Scott on his 75th birthday. The meeting will be held at the New Haven Lawn Club at 7:00 p.m., Tuesday, September 19, 1939. Approximately 20 leading engineering and scientific societies with which Professor Scott has been closely associated in his long career are co-operating with the Connecticut Section to honor him on this occasion.

Professor Scott was president of AIEE in 1902–03 and was recipient of the Edison Medal in 1929. He was prime mover in the organization of the Connecticut Section and was its first chairman. He has been a leader in the field of engineering and engineering education, having been associated with Westinghouse Electric and Manufacturing Company from 1888 to 1911, and professor of electrical engineering at Yale University from 1911 to 1933. His interest in Institute and scientific affairs is undiminished today and he directs a large proportion of his time and energy to engineering education. He is very active in the Society for the Promotion of Engineering Education and the Engineering Council for Professional Development, and is president of the National Council of State Boards of Engineering Examiners.

The principal speaker of the evening will be AIEE President F. Malcolm Farmer. Invited guests include the board of directors, past-presidents, and all members of AIEE, and members of the many other engineering and scientific societies with which Professor Scott has been associated. Many of his former students will be present. Russell G. Warner, United Illuminating Company, New Haven, Conn., is chairman of the general committee in charge of the dinner.

AIEE Directors Meet at New York World's Fair

THE regular meeting of the board of directors of the AIEE was held in the Consolidated Edison Company building at the New York World's Fair August 4, 1939.

Present: *President*—F. Malcolm Farmer, New York, N. Y. *Past Presidents*—John C. Parker, New York, N. Y.; W. H. Harrison, New York, N. Y. *Vice-Presidents*—T. F. Barton, New York, N. Y.; F. C. Bolton, College Station, Texas; Chester L. Dawes, Cambridge, Mass.; E. E. George, Chattanooga, Tenn.; C. T. Sinclair, Pittsburgh, Pa.; J. M. Thomson, Toronto, Ont. *Directors*—C. R. Beardsley, New York, N. Y.; Mark Eldredge, Memphis, Tenn.; L. R. Mapes, Chicago, Ill.; K. B. McEachron, Pittsfield, Mass.; H. S. Osborne, New York, N. Y.; C. A. Powel, East Pittsburgh, Pa.; D. C. Prince, Philadelphia, Pa.; R. W. Sorensen, Pasadena, Calif. *National Treasurer*—W. I. Slichter, New York, N. Y. *National Secretary*—H. H. Henline, New York, N. Y. Present by invitation: C. R. Jones, New York, N. Y., *former director*.

Minutes of the meeting of the board of directors held June 29, 1939, were approved.

Report was presented and approved of recommendations adopted by the board of examiners at a meeting held July 20, 1939. Upon recommendation of the board of examiners, the following actions were taken: 12 applicants were transferred to the grade of Fellow; 58 applicants were transferred, 13 elected, and 3 re-elected to the grade of Member; 97 applicants elected and 11 re-elected to the grade of Associate; 11 Students were enrolled.

The finance committee reported disbursements in July amounting to $35,956.20, and the report was approved.

Upon nomination by the standards committee, it was voted that K. B. McEachron, A. C. Monteith, and H. R. Stewart be appointed Institute representatives on the sectional committee on lightning arresters, C62, now being organized under ASA procedure.

Announcement was made of the appointment by the president of Institute committees for the administrative year beginning August 1, 1939 (list published elsewhere in this issue).

As required by the bylaws of the Edison Medal committee, the board confirmed the following appointments by the president: W. B. Kouwenhoven, F. V. Magalhaes, and L. W. W. Morrow as members of the committee for the five-year term beginning August 1, 1939, and of L. W. W. Morrow as chairman for the year 1939–40. The board elected from its own membership to serve as members of the committee for the term of two years beginning August 1, C. R. Beardsley, Mark Eldredge, and John C. Parker.

In accordance with the bylaws of the Lamme Medal committee, the board confirmed the president's appointment of F. F. Brand, Howard Maxwell, and C. A. Powel as members of that committee for the term of three years beginning August 1, 1939, and of R. E. Hellmund to serve for the unexpired term, ending July 31, 1940, of C. F. Hirshfeld, who resigned from the committee shortly before his death.

There was considerable discussion as to whether the committee on legislation affecting the engineering profession had the proper title and whether its functions should include those of the special committee on Model Registration Law, the past activities of the legislation committee having dealt largely with licensing matters. C. R. Beardsley, chairman of the special committee on Model Registration Law and newly appointed chairman of the committee on legislation affecting the engineering profession, recommended the combination of the two committees' functions, the personnel of the special committee to be included in the membership of the legislation committee for the present year. Therefore, as the work originally assigned to the special committee has been completed, it was voted to discharge the special committee on Model Registration Law with sincere appreciation of its services.

Representatives of the Institute on various organizations were appointed for the one-year term beginning August 1, 1939. O. W. Eshbach was appointed a representative on the Engineers' Council for Professional Development for the three-year term beginning October 1939; W. S. Barstow was reappointed a representative on the library board, United Engineering Trustees, Inc., for a four-year term beginning in October 1939; and L. W. Chubb was nominated for reappointment by the Engineering Foundation Board as the Institute representative on the research procedure committee of the Foundation.

Local honorary secretaries were appointed for the two-year term beginning August 1, 1939, as follows: A. F. Enstrom for Sweden; A. P. M. Fleming for England; and P. H. Powell for New Zealand.

Other matters were discussed, reference to which may be found in this or future issues of ELECTRICAL ENGINEERING.

Future AIEE Meetings

Great Lakes District Meeting
Minneapolis, Minn., September 27–29, 1939

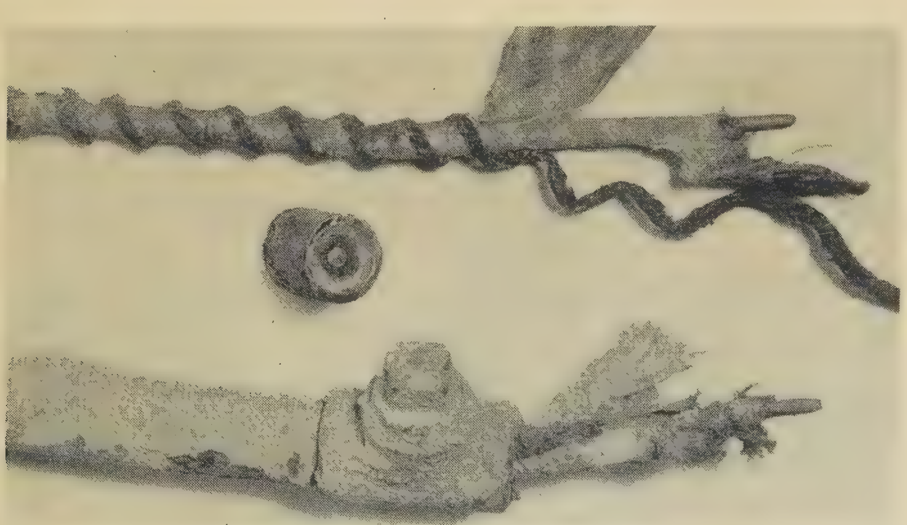
Middle Eastern District Meeting
Scranton, Pa., October 11–13, 1939

Winter Convention
New York, N.Y., January 22–26, 1940

Summer Convention
Swampscott, Mass., June 24–28, 1940

Pacific Coast Convention
Vancouver, B. C., August 27–30, 1940

Conduit 64 Years Old Found at Cornell



SECTIONS of wrought-iron pipe, found by workmen digging on the campus of Cornell University, Ithaca, N. Y., have been identified as part of the conduit laid in 1875 for what is said to be the first outdoor electric-lighting system in the Western Hemisphere. Electricity for lights on the campus was provided by a dynamo built in the Cornell shops in 1875. The dynamo is still capable of being used, and, according to the electrical-engineering school faculty, the pipe could also still perform its original function. Strips of muslin were used to protect the copper wire in the center of the pipe and the intervening space was filled with beef tallow secured for the experiment from a local butcher. The illustration shows pipe, wire, and method of insulation.

Coffin Medal Awarded. The Charles A. Coffin Medal, awarded annually for distinguished contribution to the development of electric light and power for the convenience of the public and the benefit of the industry, was won for 1938 by the Wisconsin Electric Power Company. The medal, with $1,000 for the employees' welfare

fund, was presented at the recent annual meeting of the Edison Electric Institute, New York, N. Y., by H. P. Liversidge (A'12, M'17) president of the Philadelphia (Pa.) Electric Company and chairman of the EEI prize awards committee. The committee cited the company's notable record in all major fields of activity, including technical accomplishment, public and employee relations, operating efficiency, financial management, over-all operation.

1939 Utility Chart. Spoken of as "a public utility manual in convenient chart form," a 34 by 28 inch chart showing at a glance interrelation and capitalization of the principal public-utility holding, operating, and investment companies as of June 1, 1939, has been issued by Robert A. Burrows, Statistician, First National Bank Building, Pittsburgh, Pa. Available either in plain black and white ($2) or in nine distinctive colors ($3) to help in tracing relationships, the chart covers comparative data for 45 major systems including interrelations of all voting stock, outstanding capitalization, per cent classification of gross revenues for various services, gross revenues in dollars, operating ratio in per cent, net income in dollars, sheer earnings, outstanding stocks, and so on. Also shown are service-area maps of the principal public-utility systems in the United States.

Oilless Circuit Breakers Demonstrated to Utility Engineers

Two circuit breakers recently developed by the General Electric Company were given demonstration tests under short-circuit conditions before a group of 270-odd utility and industrial engineers and executives, gathered at the high-power testing laboratory of the company's Schenectady works August 17, 1939.

The unit demonstrated in the morning's period of tests was a 15-kv 600-ampere air-blast circuit breaker having a rated interrupting capacity of 500,000 kva at 60 cycles. This was a three-phase, completely enclosed, air-operated cubicle-type unit, intended for power-station or industrial applications. Similar in general dimensions to the company's long-established *H*-type oil circuit breakers, the unit reflects the first serious attempt to apply to American power systems a principle of circuit interruption that has prevailed for some time and in various forms in Europe, where the concentrations of power are notably less. Duty cycles imposed on this breaker during demonstration tests included opening a short circuit of 630,000 kva, and a close-open cycle against a short circuit of 730,000 kva. In the first instance, the circuit was cleared within 5.9 cycles (60-cycle basis) of the initial tripping impulse and 0.3 cycle after the arc was struck by the parting contacts; in the latter instance these respective figures were 6.0 cycles and 0.5 cycle. Examination of the vital parts after a series of seven tests revealed amazingly little wear on either the moving or stationary contacts.

The afternoon's series of tests was applied to an oilless breaker utilizing a special adaptation of the magnetic-blowout principle. The three-phase five-kv unit tested had a normal rating of 1,200 amperes and an interrupting capacity of 100,000 kva at 60 cycles. Opening a short circuit of 140,000 kva, this breaker cleared the circuit within 4.3 cycles (60-cycle basis) of the initial tripping impulse; 0.3 cycle after the arc was struck. In a close-open cycle against a 125,000-kva short circuit, the circuit was cleared within 4.8 cycles of the initial tripping impulse; 0.7 cycle after the arc was struck.

Acting as informal master of ceremonies and commentator for the tests, D. C. Prince (A'16, F'26) chief engineer of the company's Philadelphia works, pointed out that the breakers, no longer in the laboratory stage, are ready for regular service. Their design has overcome two important limitations of European-type air circuit breakers, inability to handle high voltages, and difficulty of standardization, he declared. Both breakers permit standard arrangement of busses, current transformers, mechanical interlocks, and associated devices.

The air-blast circuit breaker demonstrated August 17, 1939, at the Schenectady, N. Y., works of the General Electric Company, is here shown (left) in a vault of the high-voltage testing laboratory. Below, stationary arcing contact of one of the breaker's interrupting units, undamaged after tests exceeding interrupting rating by 50 per cent, is being exhibited by H. E. Strang (A'28) General Electric switchgear engineer

Bell Laboratories to Add New Building

Construction of a new laboratory unit at Murray Hill, N. J., has been authorized by the board of directors of Bell Telephone Laboratories. The building, which is expected to cost about $3,000,000, will house about 800 persons, or 17 per cent of the personnel of the Laboratories. Laboratories for several divisions of the research and apparatus development departments, including physical research, standards, outside plant development, material standards, and others, will be provided in the new building, which is expected to be ready for occupancy during 1941.

Current Items From American Engineering Council

Registration of Engineers in the District of Columbia

Although legislation providing for the registration of engineers in the District of Columbia did not become law before the first session of the 76th Congress adjourned, it passed the Senate on July 18 and is now pending before the Committee on the District of Columbia of the United States House of Representatives. This is more progress toward enactment than has hitherto been made by any of the similar measures introduced in preceding Congresses.

The proposed legislation, introduced by Senator King in the Senate (S.1128) and Representative Randolph in the House of Representatives (H. R. 4792), has had the united support of the engineering organizations of the District of Columbia acting through the Council of Engineering and Architectural Societies.

Through extended conferences and hearings, the subcommittee of the Senate District Committee in charge of the legislation made every effort to present to the Senate a bill that would be representative of the point of view of engineers and engineering organizations within the District, and was successful to the extent that the Senate passed the legislation as reported with almost no debate and with no amendments other than those recommended by the committee.

Encouraged by the approval of the Senate, those supporting the measure were hopeful that the House District Committee would report the Randolph bill favorably at its meeting of July 21. However, between the date of passage of the King bill in the Senate and the July 21 meeting of the House District Committee, representatives of several national organizations emphatically protested enactment of the legislation until its provisions had been broadened. Since the House District Committee had given no consideration to the matter other than to refer it to the District Commissioners and to its own subcommittee on the Judiciary for study and report, a few of its members felt that the committee did not have sufficient information on which to base action and expressed the belief that further hearings probably should be held. As a result the House District Committee voted to hold the Randolph bill in committee until Congress reconvenes in January, at which time the legislation will be taken up again.

Future Meetings of Other Societies

American Chemical Society. Fall meeting, September 10–15, Boston, Mass.

American Institute of Physics. Temperature symposium, November 2–4, New York, N. Y.

American Physical Society. 230th meeting, December 1–2, Chicago, Ill.
231st meeting, December.
Annual meeting (232d), December 28–30, Columbus, Ohio.

American Society of Mechanical Engineers. Joint meeting ASME Fuels Division, AIME Coal Division, October 5–7, Columbus, Ohio.
Annual meeting, December 4–8, New York, N. Y., and Philadelphia, Pa.

Association of Iron and Steel Engineers. Annual convention, September 26–29, Pittsburgh, Pa.

Conference on Electrical Insulation (National Research Council). November, Cambridge, Mass.

Electrochemical Society. Fall convention, September 11–13, New York, N. Y.

Institute of Radio Engineers. 14th annual convention, September 20–23, New York, N. Y.
Fall meeting, November 13–15, Rochester, N. Y.

National Electrical Contractors Association. October 9–12, Philadelphia, Pa.

National Electrical Manufacturers Association. October 23–27, Chicago, Ill.

National Safety Council. October 16–20, Atlantic City, N. J.

Société Française des Électriciens. Television meeting, November, Paris, France.

Society of Automotive Engineers. National aircraft production meeting, October 5–7, Los Angeles, Calif.

Congress Acts to Improve Patent Procedure

Of the several bills introduced into Congress to improve patent procedure, as a result of testimony before the Temporary National Economic Committee, five were passed by both the House of Representatives and the Senate. It is anticipated that they will be signed by the President promptly since the legislation proposed now has the approval of the Department directly affected, the Department of Commerce. They are:

H. R. 6872. Reduction in the time allowed for public use of an invention before applying for a patent from two years to one year.

H. R. 6873. Simplification of the present interference practice, which decides which of two conflicting applications shall be granted, by referring the matter to a three-man board of interference examiners and issuing a patent immediately in consonance with their decision. Thereafter the losing party can, if he wishes, appeal the matter but the present long delay in issuance whenever such appeal is taken is eliminated.

H. R. 6874. Reduction of the time for paying the final patent fee from six to three months after notice that the application has been approved. The Commissioner is given discretion to extend this time an additional year if justification for the delay is demonstrated.

H. R. 6875. Limitation of the time for copying claims into an application from prior patents to those issued within one year, rather than two.

H. R. 6878. Reduction in the allowed time for responding to Patent Office communications from the present six months to not less than 30 days, at the discretion of the Commissioner.

At the time these bills were before the Senate for consideration, Senator O'Mahoney presented to the Senate the recommendations of the Temporary National Economic Committee with respect to patent procedure and pointed out that H. R. 6872 was the fifth of the Temporary National Economic Committee recommendations, H. R. 6873 the third, H. R. 6874 the fourth, H. R. 6875 the sixth, and H. R. 6878, the seventh.

Two other bills are on the Senate calendar which have not yet received the approval of that body. They are:

S. 2687. Setting up a single Court of Patent Appeals to which shall be referred all appeals from decisions of U. S. District Courts regarding patent cases.

S. 2688. Termination of the life of a patent at 17 years after date of issue or 20 years after date of application, whichever is shorter. The former has been passed over on each occasion it has been due for discussion. The latter was passed but returned to the calendar for further consideration.

H. R. 6721. Providing for reclassification of Patent Office records by a force of 25 additional examiners whose entire time shall be devoted to the task—has been passed by the House of Representatives but has not been reported by the Senate Patents Committee.

Senator O'Mahoney pointed out that "other patent recommendations made by the Temporary National Economic Committee deal rather with the uses to which patent privileges are put in the control of industry" and that "no bills had been introduced by any congressional member of the TNEC dealing with these recommendations because of the desire of TNEC that full consideration be given to the recommendations which have been made."

Letters to the Editor

CONTRIBUTIONS to these columns are invited from Institute members and subscribers. They should be concise and may deal with technical papers, articles published in previous issues, or other subjects of some general interest and professional importance. ELECTRICAL ENGINEERING will endeavor to publish as many letters as possible, but of necessity reserves the right to publish them in whole or in part, or reject them entirely.

ALL letters submitted for consideration should be the original typewritten copy, double spaced. Any illustrations submitted should be in duplicate, one copy to be an inked drawing but without lettering, and the other to be lettered. Captions should be furnished for all illustrations.

STATEMENTS in these letters are expressly understood to be made by the writers; publication here in no wise constitutes endorsement or recognition by the American Institute of Electrical Engineers.

Kirchoff's Equations in a Many-Dimensional Representative Space

To the Editor:

Referring to my letter on the subject in ELECTRICAL ENGINEERING, May issue, page 225, my attention has been called to the fact that Professor E. A. Guillemin of the Massachusetts Institute of Technology has previously used a many-dimensional current vector orthogonal to the subspace formed by the vectors of the network parameters ("Communication Networks," 1931, volume 1, chapter 7, page 256). This anticipates

my proposition I. I am glad to be corrected especially in view of the fact that in the same chapter of Professor Guillemin's book an interested person will find further details that will facilitate an application of the general propositions to electrical network problems.

Very truly yours,
VLADIMIR KARAPETOFF (A'03, F'12)

(Professor emeritus of electrical engineering, Cornell University, Ithaca, N. Y.; consulting engineer, Leonia, N. J.)

Bus Protection

To the Editor:

In TRANSACTIONS, May section, an AIEE-EEI committee report classified bus-protection schemes and stated that the fault bus gave protection against ground faults only. Although this is true in a sense, it is rather unfair to those fault bus installations in which the fault current may not reach the ground or ground bus, but may be essentially confined to the fault bus, and the resultant ground current may be negligible or zero. In the company by which the writer is employed, some of the fault bus schemes are "residual" and the others "three phase." In the three-phase type each phase has a separate fault bus conductor and a separate current transformer, or the equivalent. The three current transformer secondaries are of such ratios and so connected that the relay current is never zero regardless of the number of phases involved with respect to the fault bus. On a completely isolated-phase bus structure, an adequate three-phase fault bus gives protection that is as complete as the most complete differential installation. On a group-phase structure this is not true, but it does give protection against what is probably the most drastic type of interphase fault, namely, that in which ground connections are left on the phases of a bus which is out of service, and live apparatus is closed to this bus in an operating error. Since the grounds which were not removed are tied to the fault bus, the fault-bus relay immediately opens the switch which was closed in error. With three symmetrical ground connections, no ground current is involved.

Very truly yours,
GEORGE W. HAMPE (A'28)

(Engineer, testing department, Commonwealth Edison Company, Chicago, Ill.)

Magnesium-Copper Sulphide Rectifier Battery Charger

To the Editor:

In the June section of the TRANSACTIONS there is a paper by C. A. Kotterman dealing with the application of dry-type rectifiers for charging the batteries for railroad passenger cars. In this article Mr. Kotterman refers to the three widely known types of dry-type rectifiers, namely, the copper oxide, the iron-selenium, and the magnesium-copper sulphide rectifiers. He states "the iron-selenium rectifier has never been considered seriously as a heavy-duty type."

I wish to correct Mr. Kotterman in this statement. The selenium-type rectifier is today the most important dry-type rectifier for power purposes and, whilst it has not been used largely on this continent, I have just completed the testing of a selenium-iron rectifier which has a normal rating of 45 amperes at 65 volts. This is being used for automatic mine locomotive battery charging, and by means of the associated choke, gives the desired characteristics for an eight-hour taper charge required for this class of work. The over-all efficiency of the entire equipment tests out to 65 per cent, this being measured from the a-c input to the 440-volt transformer, to the d-c output. I have had occasion to use selenium-iron rectifiers for other applications in the last year or so, and if Mr. Kotterman will refer to a recent book "Trockengleichrichter, Theorie, Aufbau und Anwendung" (Dry Rectifiers, Theory, Construction and Application) by Karl Maier, published by R. Oldenbourg of Munich and Berlin in 1938, he will find a great deal of information regarding the use and application of selenium-iron rectifiers. They are used for electrolytic purposes arranged in groups for delivering as much as 5,000 amperes at 6 and 12 volts, and for delivering one-half ampere at 4,000 volts and at almost every conceivable application falling between these ranges. In certain applications they can be designed for over-all efficiencies of 75 per cent and 80 per cent including the transformer.

Yours very truly,
F. J. BARTHOLOMEW (A'26, M'35)

(President, Electric Power Equipment, Ltd., Vancouver, B. C., Canada)

Personal Items

H. T. Friis (A'20, M'26) research engineer, Bell Telephone Laboratories, New York, N. Y., has been awarded the Morris Liebmann Memorial Prize for 1939 by the Institute of Radio Engineers. The award was conferred in recognition of "his investigations in radio transmission, including the development of methods of measuring signals and noise and the creation of a receiving system for mitigating selective fading and noise interference." A native (1893) of Denmark, Mr. Friis received the degree of electrical engineer from the Royal Technical College, Copenhagen, in 1916. He did research at that institution and was technical adviser to the Royal Gun Factory in Copenhagen, before coming to the United States in 1919 for graduate study at Columbia University on a fellowship from the American Scandinavian Foundation. He was a research engineer with Western Electric Company, New York, N. Y., from 1920 until 1925, when he became associated with the Bell Laboratories.

H. T. FRIIS

C. E. Oakes (A'17, M'20) has been elected president of the Birmingham Electric Company, Birmingham, Ala., and will also serve the company as general manager. A native (1892) of Pendleton, Ore., Mr. Oakes received the degrees of bachelor of science in electrical engineering from Oregon Agricultural College in 1915 and of master of mechanical engineering from Cornell University in 1917. He was an assistant instructor and later instructor in electrical engineering at Oregon Agricultural College, Corvalis, in 1914–16, and in 1917 was appointed assistant electrical engineer for the Bureau of Standards, Washington, D. C. He was later employed by the Federal Power Commission, before becoming associated with the Pennsylvania Power and Light Company in 1923. He continued with that company until his recent appointment, having been manager of the Allentown (Pa.) division since 1927.

C. E. OAKES

Vladimir Karapetoff (A'03, F'12) retired in June 1939 as professor of electrical engineering at Cornell University, Ithaca, N. Y., and has been made professor emeritus by the trustees of the university. Born in St. Petersburg (Leningrad), Russia, January 8, 1876, he received the degrees of civil engineer (1897) and master of mechanical engineering (1902) from the Imperial Institute of Ways of Communication, Leningrad, and studied electrical engineering at the Polytechnic Institute, Darmstadt,

Germany, in 1899–1900. He also received the honorary degrees of doctor of music from New York College of Music, 1934, and of doctor of science from Brooklyn Polytechnic Institute, 1937. He came to America on a traveling fellowship in 1903, becoming a special engineering apprentice with Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa. He joined the Cornell faculty in 1904 as assistant professor of electrical engineering, becoming professor in 1908. He has been consulting engineer to a number of organizations and will continue his consulting practice. He has been a trustee of Ithaca College, Ithaca, N. Y., since 1933, and holds a commission as lieutenant commander in the United States Naval Reserve Forces. Inventor of electrical devices and musical instruments, and author of numerous technical books and articles, Doctor Karapetoff is a member of a number of honorary and technical societies and has received the Montefiore Medal of the Belgian Association of Electrical Engineers (1923) and the Eliot Cresson Medal of the Franklin Institute (1927).

J. D. Noyes (A'07, M'20) engineer on the president's staff of the Detroit Edison Company, Detroit, Mich., retired recently. Born in Baraboo, Wis., in 1880, Mr. Noyes received the degree of bachelor of science in electrical engineering from the University of Wisconsin in 1904, and the same year became a student apprentice of Westinghouse Electric and Manufacturing Company, at East Pittsburgh, Pa. He was transferred to Philadelphia in 1906, where he was an engineer in the construction department, and two years later was transferred to the company's Detroit sales office, where he continued until 1914, specializing in factory power applications. He went with the Detroit Edison Company as a sales engineer in 1914, becoming senior sales engineer in 1918, and being assigned to the president's staff in 1926.

D. M. Jones (A'21) has been appointed manager of the engineering division of the central station department, General Electric Company, Schenectady, N. Y. A native (1886) of Cambria, Wis., Mr. Jones received the degrees of bachelor of arts (1905) from the University of Minnesota, and bachelor of science (1917) from Massachusetts Institute of Technology. From 1905 to 1914 he was engaged in electrical operation and construction. He started with General Electric in 1917 in the student test course, entering the lighting engineering department in 1918, and the central station department in 1923. Before his recent appointment he was in charge of the sponsor engineers section of the department.

W. C. Johnson, Jr. (A'29) has been appointed director of placement and associate professor of vocational guidance at Virginia Polytechnic Institute, Blacksburg. After receiving the degrees of bachelor of science at Princeton University, 1925, and electrical engineer, Rensselaer Polytechnic Institute, 1927, he was associated with General Electric Company in the testing and design departments, as instructor in engineering courses, and as consultant to the air-conditioning department. From 1933 until his present appointment he has been assistant professor of physics and field secretary on admissions at Rensselaer Polytechnic Institute, Troy, N. Y.

E. M. Melton (A'36) sales engineer with Canadian National Carbon Company, Ltd., and Acheson Graphite Corporation, has been transferred to Calcutta, India, to represent those organizations in the Far East. He has been associated with National Carbon Company, Inc., on application and sale of carbon products since 1933, and since 1936 had been in the New York metropolitan district.

B. M. Jones (A'20, M'24) has been appointed chairman of the electrical section of the Engineers' Society of Western Pennsylvania. Mr. Jones, who is also chairman of the membership committee of the AIEE Pittsburgh Section, is division engineer of system planning, Duquesne Light Company, Pittsburgh, Pa.

G. H. Temple, Jr. (A'38) formerly a research assistant at Massachusetts Institute of Technology, Cambridge, has become associated with A. G. Spalding and Brothers, New York, N. Y., in charge of operation of a multi-flash stroboscopic light source used for photographic analysis of golf swings.

H. J. MacLeod (A'23) professor and head of the department of electrical and mechanical engineering, University of British Columbia, Vancouver, B. C., Canada, has been appointed technical advisor to the British Columbia Public Utilities Commission.

H. T. Plumb (A'03, M'21) has been appointed consulting engineer for the Rocky Mountain district by General Electric Company. He will have headquarters at Denver, Colo. He has been with the company since 1910, and since 1912 has been local engineer at the Salt Lake City office.

H. R. Summerhayes (A'07, M'16) has been appointed consulting engineer of the central station department, General Electric Company, Schenectady, N. Y. He had been manager of the engineering division of that department since 1925.

G. A. Mills (M'18) formerly president of the Kansas Electric Power Company, Lawrence, Kans., has been transferred to the Corpus Christi, Tex., office of the Central Power and Light Company, where he will be employed in a special capacity.

C. C. Long (A'14, M'30) senior electrical engineer, Metropolitan Water District, City of Los Angeles, Calif., has a temporary assignment with the Bonneville Project, Portland, Ore., during a three-month leave of absence from his Los Angeles position.

G. T. Harness (A'30, M'36) instructor in electrical engineering at Columbia University, New York, N. Y., has been promoted to the rank of assistant professor.

P. R. Roehm (A'38) formerly assistant engineer with New Orleans (La.) Public Service, Inc., has become associated with Ebasco Services, Inc., New York, N. Y.

A. E. Allen (A'06, M'13) formerly vice-president, Westinghouse Electric and Manufacturing Company, Mansfield, Ohio, has been elected a director of Landers, Frary, and Clark, New Britain, Conn.

J. A. Mayer (A'37) formerly manager of the Cleveland, Ohio, office of the Graybar Electric Company, has been appointed supply sales manager, with headquarters in New York, N. Y.

F. H. Murphy (A'07, F'30) consulting engineer, Portland General Electric Company, Portland, Ore., has been appointed a member of the Oregon State Board of Engineering Examiners.

A. D. Colvin (A'09, M'13) executive vice-president, Connecticut Power Company, New London, has been appointed a member of the Groton-New London bridge commission.

Obituary

Lancelot Richard Woodcock (A'09, M'20) divisional chief, Ebro Irrigation and Power Company, Barcelona, Spain, died July 1, 1939, at Barcelona. Born July 10, 1880, at Warwick, Queensland, Australia, he received the degree of bachelor of engineering in mechanical and electrical engineering from the University of Sydney in 1905. From 1896 to 1898 he served an apprentice course with Barton and White, electrical engineers, Brisbane. After graduation he was an assistant lecturer in mechanical engineering at the University of Sydney, Sydney, New South Wales, in 1905–06. Coming to the United States he was employed by the General Electric Company, Schenectady, N. Y., in the testing and turbine powerhouse departments, in 1907 and 1908, and in the latter year became associated with the Washington Water Power Company, Spokane, on construction of hydroelectric power plants. In 1915 he returned to Australia and became manager of the electrical department of the Engineering Supply Company of Australia, Brisbane. During 1917–18 he was assistant electrical engineer, factories branch, Ministry of Munitions, London, England. In 1919 he first became associated with the Ebro Irrigation and Power Company as resident engineer at Barcelona. From 1921 to 1923 he was in New York, N. Y., as engineer on the construction of the Hell Gate power station, for the Brooklyn (N. Y.) Edison Company, and on the Sherman Creek power station. He was general superintendent at the Sivasamudram power plant of the Mysore Government, India, 1924–26, and in 1927 returned to the Ebro Irrigation and Power Company as divisional chief at Tremp, Spain. He continued in that position until recalled after the outbreak of the Spanish Civil War in 1936, returning in April 1938.

Frederick Milton Servos (A'19, M'27) whose death on July 8, 1939, was mentioned in the August issue, page 363, was born October 25, 1894, in Niagara township, Ontario, Canada. He received the degree of bachelor of applied science in the electrical-engineering department of the Uni-

versity of Toronto in 1914, and in the same year was employed as an engineering assistant by the Public Utilities Commission of the City of St. Catharines, Ont., becoming superintendent in 1916. In 1918 he became works manager of Tudhope Electro Metals, Ltd., Vancouver, B. C., and in 1919 was employed as an electrical engineer by the United States Ferro Alloys Corporation, Niagara Falls, N. Y. He was electrical and mechanical superintendent for the Canadian Electric Steel Company, Ltd., Montreal, Que., in 1920–21. In 1922 he was employed by the Canadian and General Finance Company, Ltd., Toronto, Ont., subsidiary and consulting and purchasing agent for the Brazilian Traction, Light, and Power Company, Ltd. He became electrical engineer in charge of electrical work in the Toronto office in 1923, and in 1924 was transferred to the parent organization in Rio de Janeiro, Brazil, as chief electrical engineer for a group of companies controlled by the Brazilian Traction Light and Power Company, including the Rio de Janeiro Tramway Light and Power Company, Ltd., Sao Paulo Tramway Light and Power Company, Ltd., Brazilian Hydro Electric Company, Ltd., Sao Paulo Electric Company, Ltd. He was returning to Ontario for reasons of health at the time of his death. He was AIEE local honorary secretary for Brazil from 1927 until his departure from Brazil in 1939.

Hugh McCollum Beugler (A'03, M'27) retired consulting engineer, died at Hamden, Conn., July 16, 1939. He was born in Williamsport, Pa., November 26, 1872, and studied at Cornell University. In 1888 he became associated with the Thomson-Houston Company where he worked on various assignments involving design and construction of power plants, electric lighting systems, and gas and water installations. During the period 1894–1900 he was with the Brush-Swan Electric Light Company, Ithaca, N. Y., and the Ithaca Street Railway, as superintendent of operation. He engaged in special engineering jobs in 1900–01, before becoming general superintendent and chief engineer of the Elmira (N. Y.) Water, Light, and Railroad Company, a position which he held until 1906 and returned to in 1908 after brief associations with Ford, Bacon, and Davis, New York, N. Y., and Day and Zimmerman, Philadelphia, Pa. From 1909 to 1911 he was manager of the electrical department, Newburgh (N. Y.) Light, Heat, and Power Company, and in 1911 he became operating manager of the Central Hudson Gas and Electric Company, Poughkeepsie, N. Y. He became a vice-president of the company in 1926, and in 1927 retired to engage in general consulting practice.

Joseph Walter Ramsay (A'36, M'38) professor of electrical engineering, University of Texas, Austin, died July 22, 1939. Born November 25, 1880, at Bloomington, Ind., he received the degrees of bachelor of science in electrical engineering from Texas Agricultural and Mechanical College in 1906, bachelor of science in electrical engineering and electrical engineer from the University of Texas in 1916. From 1906 to 1908 he was a student apprentice with Westinghouse Electric and Manufacturing Company, Pittsburgh, Pa. During the next three years he was employed in various capacities by the Benton Harbor-St. Joseph (Mich.) Light and Power Company, the Southern Pacific Railway, and the Barden Electric and Machinery Company, Houston, Tex. In 1911 he became an instructor in the department of electrical engineering at the University of Texas, Austin, where he continued until 1917. During the World War he served as lieutenant and captain in the United States Army, with air service troops at Kelly Field, Tex., and on the Mexican border, and was in charge of aerial gunnery at the School of Military Aeronautics, located at the University of Texas. He became professor of applied electricity at Washington State College, Pullman, for the term 1919–20, and in 1920–21 was assistant professor of electrical engineering at Texas Agricultural and Mechanical College, College Station. In 1921 he returned to the University of Texas with the rank of associate professor, becoming full professor in 1938. He was a member of the Society for the Promotion of Engineering Education, and Eta Kappa Nu.

John P. Garvin (A'23, M'29) resident engineer, New York State Electric and Gas Company, Elmira, died May 12, 1939. Born in Minneapolis, Minn., July 26, 1891, he received the degree of bachelor of science in electrical engineering from Montana State College in 1917. He served in the United States Army during the World War as a second lieutenant in the Coast Artillery. From 1919 to 1926 he was employed successively as engineer by the Montana State Highway Department, operator at the Holter plant of the Montana Power Company and at the Tumwater plant of the Great Northern Railway; junior electrical engineer, United States Bureau of Mines, Pittsburgh, Pa.; and switchboard engineer, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa. In 1926 he became central station layout engineer for W. S. Barstow and Company, Reading, Pa. Later he was electrical engineer for the Metropolitan Edison Company, and resident engineer for the E. M. Gilbert Engineering Corporation, both at Reading, before assuming the position with the New York State Company which he held at the time of his death.

George David Wilkinson (A'25) assistant automatic chief, Western Union Telegraph Company, New York, N. Y., died July 5, 1939. He was born at Rochester, N. Y., May 1, 1881, and took electrical courses at the Mechanics Institute in Rochester and at Lowell Institute. In 1896 he became a telegraph operator for Postal Telegraph Cable Company, Rochester, and later occupied the same position with Western Union Company, Boston, Mass., and the New York, New Haven, and Hartford Railroad Company, Boston. He became employed by the American Telephone and Telegraph Company, Boston, in 1900, and in 1902 was made exchange manager of New England Telephone and Telegraph. From 1907 to 1910 he was with Western Union in Boston, from 1910 to 1914 with Postal Telegraph Cable Company, New York, N. Y. He became assistant automatic chief and instructor in automatic telegraphy for Western Union in New York in 1914, and except for a period with the United States Army Signal Corps as instructor in telegraphy and consulting engineer, continued with that company in various positions until his death.

Ottomar Carl Spangenberg (A'16), electrician, Mount Sinai Hospital, New York, N. Y., died June 6, 1937, according to information recently received. He was born May 8, 1860, at Koenigsberg, Germany, and came to the United States in 1871. He studied at private schools and at Stevens Institute of Technology and Cooper Union. In 1881 his electrical experience began in the Weston shops of the United States Electric Light Company, Newark, N. J., afterward the shops of the Westinghouse Electric and Manufacturing Company. He went to Philadelphia, Pa., in 1886 as foreman for Rees and Fitzgerald, and in 1888 was employed by the Queen City Electric Company, Cincinnati, Ohio, to do experimental work. He later engaged in independent construction of dynamos and installed plants for the Continental Dynamo Company, New York, N. Y., and others. In 1905 he became electrician at Mount Sinai Hospital, having charge of lights, power, heating devices, and medical electrical devices, including X-ray apparatus, and continued there until his death.

Benjamin Franklin Cleaves (A'23) vice-president in charge of operation, Pennsylvania Edison Company, Altoona, Pa., died July 30, 1939. Born June 28, 1885, at Addison, Maine, he studied engineering at Lowell Institute. During 1904 and 1905 he was with the Westinghouse Electric and Manufacturing Company at East Pittsburgh, Pa., and from 1906 to 1911 with the General Electric Company at Lynn, Mass. In 1911 he was employed by what was then the Penn Central Light and Power Company, Altoona, as engineer of tests. He became electrical engineer in 1916, assistant superintendent of operations in 1924, general superintendent of operations in 1925, vice-president in 1928, and retained the last-named position when the company became the Pennsylvania Edison Company. He was chief engineer of the Municipal Service Company, Altoona, from 1929 to 1931, and vice-president from 1931 to 1935. He was a member of the Edison Electric Institute.

Emmons Thomas Gray (A'23) manager of electrical distribution, Central Hudson Gas and Electric Company, Poughkeepsie, N. Y., died July 6, 1939. He was born August 1, 1896, at Fitchburg, Mass., and received the degree of electrical engineer from Rensselaer Polytechnic Institute in 1922. During the World War he was a pilot in the air service of the United States Army. He was later employed by the Troy (N. Y.) Gas Company, electrical department, and by the Depew and Lancaster Light, Power, and Conduit Company, Lancaster, N. Y., as head of the engineering

department, and later as general superintendent. He was employed by the Central Hudson Gas and Electric Company as district operating superintendent, later becoming division superintendent, and for several years had been in charge of electrical distribution. He had been with the company about 13 years.

Clifton Penn Hughes (M'39) director of Hackbridge Electric Construction Company, Ltd., and Hewittic Electric Company, Ltd., Hersham Works, Walton-on-Thames, England, died July 7, 1939. He was born at Penarth, Wales, February 11, 1905, and was educated at Oundle School and Manchester Technical College. He was an apprentice engineer at Metropolitan Vickers Electrical Company, Ltd., Manchester, England, 1924–26, and at Westinghouse Electric and Manufacturing Company, Sharon, Pa., and Pittsburgh, Pa., 1927–28. He became assistant manager of the Hackbridge company in 1929, and assumed the position of director of the Hackbridge and Hewittic companies in 1935.

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Applications for Election

Applications have been received at headquarters from the following candidates for election to membership in the Institute. Names of applicants in the United States and Canada are arranged by geographical Districts. If the applicant has applied for direct admission to a grade higher than Associate, the grade follows immediately after the name. Any member objecting to the election of any of these candidates should so inform the national secretary before September 30, 1939, or November 30, 1939, if the applicant resides outside of the United States or Canada:

United States and Canada

1. North Eastern

D'Esopo, F. P., Wiremold Company, Hartford, Conn.
Hall, W. M., Massachusetts Institute of Technology, Cambridge.
Kent, M. F., General Electric Company, Schenectady, N. Y.
Shea, D. J. (Member), Charles T. Main, Inc., Boston, Mass.

2. Middle Eastern

Barlow, P. M. (Member), West Virginia Engineering Company, Charleston.
Brecht, W. A. (Member), Westinghouse Electric and Manufacturing Company, East Pittsburgh Pa.
Warrington, C. M. (Member), Pennsylvania Power and Light Company, Sunbury.

3. New York City

Bozzella, S. J., Davis Street, Locust Valley, N. Y.
Holbrook, B. D., Bell Telephone Laboratories, Inc., New York, N. Y.
Nauman, O. H., Long Island Lighting Company, Glenwood Landing, N. Y.
Rudolph, E. W. (Member), Petroleum Heat and Power Company, Inc., New York, N. Y.
Snow, H. B. (Member), Public Service Electric and Gas Company, Newark, N. J.
Walker, D. B. (Member), Moore McCormick Line, New York, N. Y.

4. Southern

Bush, L. R., 419 Palmer Building, Atlanta, Ga.
Callaway, J. L., Taylor County Electric Membership Corporation, Reynolds, Ga.
Coulbourn, E. R. (Member), Alabama Power Company, Birmingham.
Watson, M. P., United Gas Pipe Line Company, Monroe, La.

5. Great Lakes

Hinshaw, W. W., University of Illinois, Urbana.
Larson, S. C., General Electric X-Ray Corporation, Chicago, Ill.
Sumpter, P. B., Commonwealth and Southern Corporation, Jackson, Mich.
Van Wingen, P. M., Commonwealth and Southern Corporation, Jackson, Mich.

6. North Central

Caulkins, L. E., Dakota Power Company, Rapid City, S. D.
Martinsen, R. E., Union Pacific Coal Company, Rock Springs, Wyo.
Slaybaugh, G. D., Public Service Company of Colorado, Denver.
Thompson, W. F., Public Service Company of Colorado, Denver.

7. South West

Hebert, A. C., C. A. & N. University, Langston, Okla.
Stewart, W. H., Sun Oil Company, Sun Pipe Line Company, Beaumont, Tex.

8. Pacific

Bowler, J. A., 1178 West Duarte Road, Arcadia, Calif.
Dilberger, H. A., Pacific Gas and Electric Company, Oakland, Calif.
Freeman, M. G., Gardner Electrical Manufacturing Company, Emeryville, Calif.

Total, United States, 30

Elsewhere

Datar, D. K., The Municipal Committee, Hingangghat (CP), India.
Nelson, J., General Electric S/A, Sao Paulo, Brazil, South America.
Shah, T. M. (Member), Rohtas Industries, Ltd., Dalmianagar District, Shahabad, Bihar, India.
Sheppard, J. H. G., Engineering Supply Company of Australia, Ltd., Brisbane, Queensland.

Total, elsewhere, 4

Addresses Wanted

A list of members whose mail has been returned by the postal authorities is given below, with the addresses as they now appear on the Institute record. Any member knowing of corrections to these addresses will kindly communicate them at once to the office of the secretary at 33 West 39th St., New York, N. Y.

Coleman, Irwin M., 581 Academy St., New York, N. Y.
Ebert, Kenneth W., 776 N. Cass St., Milwaukee, Wis.
Hall, John R., c/o Patrick Tyrrell Drilling Co., Cotton Exchange Bldg., Houston, Texas
James, George Hazard, Jr., 7 Meikle Ave., Newport, R. I.
McCarthy, C. C., c/o Westinghouse Electric and Manufacturing Co., 814 Ellicott Square, Buffalo, N. Y.
Modisette, M. H., 4514—16th St., N. E., Seattle, Wash.
Strauss, Walter A., 39 West 69th St., New York, N. Y.

7 Addresses Wanted

Engineering Literature

New Books in the Societies Library

Electrical engineers may be interested in the following new books, which are among those recently received at the Engineering Societies Library, New York, N. Y. Unless otherwise specified, books listed have been presented by the publishers. The Institute assumes no responsibility for statements made in the following summaries, information for which is taken from the preface of the book in question.

TRANSACTIONS THIRD WORLD POWER CONFERENCE, 1936. Ten Volumes, edited by O. C. Merrill, Washington, D. C., World Power Conference, Superintendent of Documents, 1938. Volume I, 423 pages; Volume II, 700 pages; Volume III, 688 pages; Volume IV, 575 pages; Volume V, 696 pages; Volume VI, 806 pages; Volume VII, 787 pages; Volume VIII, 825 pages; Volume IX, 509 pages; Volume X, 897 pages, illustrated, 10 by 6 inches, cloth, $2.50 per volume; $22.00 per set of ten volumes; 25 per cent discount for 100 volumes or more in a single order. These ten volumes contain a full record of the meetings of the third conference, held in Washington, 1936. Its theme was "The national power economy; its physical and statistical basis; its technical, social, and economic trends; the relation thereto of the fuel producing, processing, and distributing industries and the electric and gas utilities; practices and policies respecting organization, control, and public regulation; national and regional planning of power development and use; conservation of fuel and water resources; rationalization of the distribution of gas and electricity; and national power and resources policies." Thirty-one countries submitted reports upon one or more of the 18 topics considered.

ENGINEERING OPPORTUNITIES. Edited by R. W. Clyne; foreword by K. T. Compton. New York and London, D. Appleton-Century Company, 1939. 397 pages, illustrated, 8 by 6 inches, cloth, $3.00. Twenty-six engineering opportunities are described in this non-technical survey of engineering activities in industry. The authors of the various chapters show in each case the industry's background, present condition, and future possibilities.

AIR-CONDITIONING ENGINEERS' ATLAS. By C. Strock and C. H. B. Hotchkiss. New York, Industrial Press, 1939. 72 pages, maps, 12 by 9 inches, cloth, $2.00. Presents in condensed and readily usable form the weather data needed by engineers in solving problems of heating and cooling. Eighteen maps of the United States, colored in zones, show the various phases of summer and winter weather which concern the heating industry. Supplementary tables give the data for the larger cities.

DIESEL HAND BOOK. By J. Rosbloom. Sixth edition. Jersey City, Diesel Engineering Institute, 1939. 720 pages, illustrated, 7 by 5 inches, leather, $5.00. This manual for operators presents fundamentals in simple language. Engine details and auxiliaries and their action are described; the principal American types of engines are presented; and practical advice is given on operation, adjustment, and maintenance. Contains questions and answers for license examinations for both marine and land service.

ELECTRICAL ENGINEERING EXPERIMENTS, THEORY AND PRACTICE. By H. R. Reed and G. F. Corcoran. New York, John Wiley and Sons, 1939. 500 pages illustrated $9^1/_2$ by 6 inches, cloth, $4.50. A textbook designed for electrical engineering laboratories. Contains an introduction and seven sections: fundamentals, d-c machines, a-c circuits, transformers, synchronous machines, induction machines, and electronics. With each experiment are included pertinent theory, laboratory exercises, and possible results.

ELECTRON OPTICS, THEORETICAL AND PRACTICAL. By L. M. Myers. New York, D. Van Nostrand Company, 1939. 618 pages, illustrated, 9 by 6 inches, cloth, $12.00. Recent improvements in vacuum technique have brought to a practical point certain applications of electron behavior, the relation of which to the science of geometric optics is discussed in this book. Includes chapters on analogies between light and electrons, the electron trajectory, electron lenses and aberrations, the electron multiplier, vacuum technique, the electron microscope, and further applications. Said to be the first work in English on this branch of vacuum physics.

THEORETICAL AND APPLIED ELECTROCHEMISTRY. By M. de K. Thompson. Third edition. New York, The Macmillan Company, 1939. 535 pages, illustrated, 9 by 6 inches, cloth, $5.00. This textbook contains a treatise on theoretical electrochemistry for the electrochemical engineer and accounts of the most important electrochemical industries and the principal applications of electrochemistry in the laboratory. Includes references for detailed descriptions.

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A collection of modern technical books is available to any member residing in North America at a rental rate of five cents per day per volume, plus transportation charges.

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F. P. Kasper — B. R. Teare
L. A. Kilgore — B. Van Ness, Jr.
O. K. Marti — F. J. Vogel
G. A. Waters

Electrochemistry and Electrometallurgy

M. F. Skinker, Chm., Consolidated Edison Co. of New York, Inc., 55 Johnson St., Brooklyn, N. Y.

J. V. Alfriend — W. B. Kouwenhoven
F. V. Andreae — C. C. Levy
E. L. Bailey — R. M. Pfalzgraff
C. Dantsizen — C. A. Powel
F. W. Godsey, Jr. — F. O. Schnure
J. E. Housley — W. R. Schofield
W. C. Kalb — N. R. Stansel
C. P. Yoder

Industrial Power Applications

J. D. Wright, Chm., General Electric Co., Schenectady, N. Y.

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C. W. Drake — J. J. Orr
J. H. Edwards — W. A. Perry
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John Grotzinger — H. W. Rogers
F. E. Harrell — F. O. Schnure
L. C. Ilsley — L. A. Umansky
R. L. Kingsland — R. L. Walsh
A. E. Knowlton — R. H. Wright

Instruments and Measurements

I. F. Kinnard, Chm., General Electric Co., West Lynn Works, 40 Federal St., West Lynn, Mass.

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C. E. Bathe — H. C. Koenig
P. A. Borden — W. B. Kouwenhoven
H. B. Brooks — Everett S. Lee
A. L. Brownlee — L. J. Lunas
C. T. Burke — Paul MacGahan
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C. L. Dawes — H. C. Rankin
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W. N. Goodwin, Jr. — W. J. Shackelton
T. S. Gray — F. B. Silsbee
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H. C. Hamilton — H. L. Thomson
F. C. Holtz — H. M. Turner
A. E. Knowlton — H. N. Walker
W. M. Young

Light, Production and Application of

D. W. Atwater, Chm., Commercial Engineering Dept., Westinghouse Lamp Div., Bloomfield, N. J.

S. K. Barrett — L. A. Hawkins
Robin Beach — S. G. Hibben
W. T. Blackwell — W. C. Kalb
H. B. Dates — R. D. Mailey
E. E. Dorting — P. S. Millar
C. L. Dows — G. T. Minasian
L. R. Gamble — A. L. Powell
C. A. B. Halverson, Jr. — E. M. Strong
I. A. Yost

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H. F. Harvey, Jr., Chm., Newport News Shipbuilding & Dry Dock Co., Newport News, Va.

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H. C. Coleman	E. H. Rothen
Ernest W. Davis	W. E. Thau
P. J. Du Mont	A. E. Waller
C. J. Henschel	F. A. Wickel
F. C. Hoelzle	O. A. Wilde
A. Kennedy, Jr.	J. L. Wilson
I. H. Osborne	R. J. Wiseman
G. A. Pierce	R. L. Witham
W. N. Zippler	

Power Generation

E. C. M. Stahl, Chm., Consolidated Edison Co. of New York, Inc., 4 Irving Place, New York, N. Y.

F. A. Annett	O. L. LeFever
Claudius E. Bennett	J. W. Lingary
W. L. Cisler	J. A. M. Lyon
C. A. Corney	C. E. Magnusson
J. H. Foote	C. H. McKnight
R. L. Frisby	F. J. Meyer
W. D. Hardaway	A. C. Monteith
N. B. Hinson	C. R. Reid
H. L. Hoeppner	Robert Treat
A. J. Krupy	Sidney Withington
Edwin D. Wood	

Power Transmission and Distribution

Raymond Bailey Chm., Philadelphia Electric Co., 900 Sansom St., Philadelphia, Pa.

D. K. Blake	J. T. Lusignan, Jr.
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C. V. Christie	E. W. Oesterreich
H. W. Clark	J. S. Parsons
Harold Cole	E. V. Sayles
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M. T. Crawford	A. E. Silver
E. W. Davis	D. M. Simmons
A. E. Davison	C. T. Sinclair
G. E. Dean	F. V. Smith
R. D. Evans	L. G. Smith
D. D. Ewing	Philip Sporn
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K. A. Hawley	W. K. Vanderpoel
L. F. Hickernell	C. F. Wagner
E. K. Huntington	H. S. Warren
J. P. Jollyman	L. F. Woodruff
W. A. Lewis	T. A. Worcester
W. W. Lewis	H. E. Wulfing

Protective Devices

K. B. McEachron, Chm., General Electric Co., 100 Woodlawn Ave., Pittsfield, Mass.

J. R. North, Vice-Chm., Commonwealth & Southern Corp., Jackson, Mich.

J. E. Clem, Secy., General Electric Co., Central Station Dept., Schenectady, N. Y.

E. H. Bancker	L. R. Ludwig
H. D. Braley	J. B. MacNeill
W. R. Brownlee	J. R. McFarlin
J. O'R. Coleman	C. W. McGill
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L. N. Crichton	C. A. Muller
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I. W. Gross	D. C. Prince
Herman Halperin	P. H. Robinson
F. C. Hanker	A. H. Schirmer
C. F. Harding	H. K. Sels
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Research

W. F. Davidson, Chm., Consolidated Edison Co. of New York, Inc., 4 Irving Place, New York, N. Y.

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V. Bush	H. H. Race
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L. A. Hawkins	E. W. Spring
H. L. Hazen	A. J. Williams
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Transportation

W. S. H. Hamilton, Chm., New York Central System, 466 Lexington Ave., New York, N. Y.

R. Beeuwkes	P. H. Hatch
Leland W. Birch	G. L. Hoard
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C. M. Davis	P. A. McGee
E. G. Davis	R. J. Needham
J. V. B. Duer	J. A. Noertker
D. D. Ewing	F. B. Powers
E. B. Fitzgerald	W. I. Slichter
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Selby Haar	L. J. Turley
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2. Middle Eastern	C. T. Sinclair, Duquesne Light Co., 435 Sixth Ave., Pittsburgh, Pa.	W. J. Lyman, Duquesne Light Co., 435 Sixth Ave., Pittsburgh, Pa.	E. E. Kimberly, Ohio State University, Columbus, Ohio
3. New York City	T. F. Barton, General Electric Co., 570 Lexington Ave., New York, N. Y.	George Sutherland, Consolidated Edison Co., of New York, Inc., 4 Irving Place, New York, N. Y.	F. H. Tallman, Cooper Union, New York, N. Y.
4. Southern	E. E. George, 417 Power Building, Chattanooga, Tenn.	A. S. Hoefflin, Louisville Gas & Electric Co., 311 W. Chestnut St., Louisville, Ky.	L. L. Patterson, Mississippi State College, State College, Miss.
5. Great Lakes	A. H. Lovell, University of Michigan, Ann Arbor, Mich.	A. G. Dewars, Northern States Power Co., 15 S. 5th St., Minneapolis, Minn.	J. H. Bowman, Purdue University, Lafayette, Ind.
6. North Central	A. L. Turner, 1112 Telephone Building, Omaha, Neb.	I. M. Ellestad, 823 Telephone Bldg., Omaha, Nebr.	G. H. Sechrist, University of Wyoming, Laramie, Wyo.
7. South West	F. C. Bolton, A. & M. College of Texas, College Station, Tex.	H. C. Dillingham, A. & M. College of Texas, College Station, Tex.	Albrecht Naeter, Oklahoma A. & M. College, Stillwater, Okla.
8. Pacific	H. W. Hitchcock, Southern California Tel. Co., Los Angeles, Calif.	W. F. Grimes, 112 W. Tenth St., Room 1206, Los Angeles, Calif.	W. J. Angermann, University of Southern California, Los Angeles, Calif.
9. North West	L. R. Gamble, Washington Water Power Co., Spokane, Wash.	H. L. Vincent, E. 916 19th Ave., Spokane, Wash.	A. L. Albert, Oregon State College, Corvallis, Ore.
10. Canada	J. M. Thomson, Ferranti Electric Ltd., Mount Dennis, Toronto, Ont.	O. W. Titus, Canada Wire & Cable Co. Ltd., Box 340, Toronto, Ont.	

NOTE: Each District executive committee includes also the chairmen and secretaries of all Sections within the District, and the District vice-chairman of the national membership committee.

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NRC, Committee on Heat Transmission

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Student Branches of the Institute

Name and Location	District	Counselor (Member of Faculty)
Akron, Univ. of, Akron, Ohio	2	J. T. Walther
Alabama Polytechnic Inst., Auburn	4	W. W. Hill
Alabama, Univ. of, University	4	Fred R. Maxwell, Jr.
Alberta, Univ. of, Edmonton, Alberta, Can	10	E. G. Cullwick
Arizona, Univ. of, Tucson	8	J. C. Clark
Arkansas, Univ. of, Fayetteville	7	C. W. Janes
Armour Inst. of Tech., Chicago, Ill	5	E. H. Freeman
British Columbia, Univ. of, Vancouver	10	W. B. Coulthard
Brooklyn, Poly. Inst. of, Brooklyn, N. Y	3	C. C. Whipple
Brown Univ., Providence, R. I	1	F. N. Tompkins
Bucknell Univ., Lewisburg, Pa	2	J. B. Miller
Calif. Inst. of Tech., Pasadena	8	F. W. Maxstadt
Calif., Univ. of, Berkeley	8	T. C. McFarland
Carnegie Inst. of Tech., Pittsburgh, Pa	2	G. R. Patterson
Case School of Applied Science, Cleveland, Ohio	2	J. R. Martin
Catholic Univ. of America, Washington, D. C	2	T. J. MacKavanagh
Cincinnati, Univ. of, Cincinnati, Ohio	2	L. R. Culver
Clarkson College of Technology, Potsdam, N. Y	1	A. R. Powers
Clemson Agri. Col., Clemson, S. C	4	S. R. Rhodes
Colorado State Col. of A. & M. Arts, Fort Collins	6	F. B. Beatty
Colorado, Univ. of, Boulder	6	H. B. Palmer
Columbia University, New York, N. Y	3	G. T. Harness
Cooper Union, New York, N. Y	3	F. H. Tallman
Cornell Univ., Ithaca, N. Y	1	E. M. Strong
Denver, Univ. of, Denver, Colo	6	B. E. Cohn
Detroit, Univ. of, Detroit, Mich	5	H. O. Warner
Drexel Inst. of Tech., Philadelphia, Pa	2	E. O. Lange
Duke Univ., Durham, N. C	4	W. J. Seeley
Florida, Univ. of, Gainesville	4	E. F. Smith
George Washington Univ., Washington, D. C	2	A. G. Ennis
Georgia School of Tech., Atlanta	4	T. W. Fitzgerald
Harvard Univ., Cambridge, Mass	1	J. D. Cobine
Idaho, Univ. of, Moscow	9	J. H. Johnson
Illinois, Univ. of, Urbana	5	E. A. Reid
Iowa State Col., Ames	5	B. S. Willis
Iowa, Univ. of, Iowa City	5	G. F. Corcoran
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Kansas State Col., Manhattan	7	O. D. Hunt
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Kentucky, Univ. of, Lexington	4	E. A. Bureau
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Lehigh Univ., Bethlehem, Pa	2	Wm. H. Formhals
Lewis Inst., Chicago, Ill	5	F. A. Rogers
Louisiana State Univ., Baton Rouge	4	M. B. Voorhies
Louisville, Univ. of, Louisville, Ky	4	S. T. Fife
Maine, Univ. of, Orono	1	A. S. Hill
Marquette Univ., Milwaukee, Wis	5	E. W. Kane
Maryland, University of, College Park	2	L. J. Hodgins
Mass. Inst. of Tech., Cambridge	1	Gordon S. Brown
Michigan Col. of Min. & Tech., Houghton	5	G. W. Swenson
Michigan State Col., E. Lansing	5	M. M. Cory
Michigan, Univ. of, Ann Arbor	5	S. S. Attwood
Milwaukee Sch. of Engg., Milwaukee, Wis	5	E. L. Wiedner
Minnesota, Univ. of, Minneapolis	5	J. H. Kuhlmann
Mississippi State Col., State College	4	H. C. Simrall
Missouri Sch. of Mines and Met., Rolla	7	J. Stuart Johnson
Missouri, Univ. of, Columbia	7	C. M. Wallis
Montana State Col., Bozeman	9	E. W. Schilling
Nebraska, Univ. of, Lincoln	6	L. A. Bingham
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New Mexico, Univ. of, Albuquerque	7	H. L. Jones
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New York Univ., New York	3	H. N. Walker
North Carolina State Col., Raleigh	4	R. S. Fouraker
North Dakota Agri. Col., Fargo	6	H. S. Rush
North Dakota, Univ. of, Grand Forks	6	H. F. Rice
Northeastern Univ., Boston, Mass	1	R. G. Porter
Northwestern Univ., Evanston, Ill	5	A. B. Bronwell
Notre Dame, Univ. of, Notre Dame, Ind	5	J. A. Caparo
Ohio Northern Univ., Ada	2	D. S. Pearson
Ohio State Univ., Columbus	2	E. E. Kimberly
Ohio Univ., Athens	2	W. M. Young
Oklahoma A. & M. Col., Stillwater	7	Albrecht Naeter
Oklahoma, Univ. of, Norman	7	C. T. Almquist
Oregon State Col., Corvallis	9	A. L. Albert
Pennsylvania State Col., State College	2	P. X. Rice
Pennsylvania, Univ. of, Philadelphia	2	Irven Travis
Pittsburgh, Univ. of, Pittsburgh, Pa	2	H. E. Dyche
Porto Rico, Univ. of, Mayaguez	3	G. F. Anton
Pratt Institute, Brooklyn, N. Y	3	D. H. Wright
Princeton Univ., Princeton, N. J	2	A. E. Vivell
Purdue Univ., Lafayette, Ind	5	J. H. Bowman
Rensselaer Poly. Inst., Troy, N. Y	1	L. C. Holmes
Rhode Island State Col., Kingston	1	W. B. Hall
Rice Institute, Houston, Texas	7	J. S. Waters
Rose Poly. Inst., Terre Haute, Ind	5	C. C. Knipmeyer
Rutgers Univ., New Brunswick, N. J	3	P. S. Creager
Santa Clara, Univ. of, Santa Clara, Calif	8	E. F. Peterson
South Carolina, Univ. of, Columbia	4	T. F. Ball
South Dakota State Col., Brookings	6	W. H. Gamble
So. Dak. State Sch. of Mines, Rapid City	6	J. O. Kammerman
Southern California, Univ. of, Los Angeles, Calif	8	W. G. Angermann
Southern Methodist Univ., Dallas, Texas	7	S. G. Lutz
Stanford Univ., Stanford University, Calif	8	H. H. Skilling
Stevens Inst. of Tech., Hoboken, N. J	3	H. C. Roters
Swarthmore Col., Swarthmore, Pa	2	J. D. McCrumm
Syracuse Univ., Syracuse, N. Y	1	C. W. Henderson
Tennessee, Univ. of, Knoxville	4	J. G. Tarboux
Texas A. & M. Col., College Station	7	H. C. Dillingham
Texas Technological Col., Lubbock	7	C. V. Bullen
Texas, Univ. of, Austin	7	
Tufts Col., Tufts College, Mass	1	E. A. Walker
Tulane University, New Orleans, La	4	M. G. Zervigon
Union Col., Schenectady, N. Y	1	
Utah, Univ. of, Salt Lake City	9	A. L. Taylor
Vermont, Univ. of, Burlington	1	E. R. McKee
Villanova Col., Villanova, Pa	2	H. S. Bueche
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Virginia Poly. Inst., Blacksburg	4	Claudius Lee
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Washington, Univ. of, Seattle	9	R. E. Lindblom
Washington Univ., St. Louis, Mo	7	H. G. Hake
West Virginia Univ., Morgantown	2	A. H. Forman
Wisconsin, Univ. of, Madison	5	R. R. Benedict
Worcester Poly. Inst., Worcester, Mass	1	V. Siegfried
Wyoming, Univ. of, Laramie	6	G. H. Sechrist
Yale Univ., New Haven, Conn	1	A. G. Conrad

Total..........121

Local Sections of the Institute

Name	District	When Organized	Membership Aug. 1, 1939	Chairman	Secretary	Secretary's Address
Akron	2	Aug. 12, '20	75	T. F. Brandt	F. W. Nimmer	Ohio Edison Co., Akron, Ohio
Alabama	4	May 22, '29	31	W. W. Hill	T. H. Mawson	Commonwealth & Southern Corp., Birmingham, Ala.
Boston	1	Feb. 13, '03	414	J. C. Balsbaugh	J. M. Murray	Simplex Wire & Cable Co., 79 Sidney St., Cambridge, Mass.
Central Indiana	5	Jan. 12, '12	126	J. G. Harden	R. A. Scholl	Northern Indiana Pwr. Co., 110 No. Illinois St., Indianapolis, Ind.
Chicago	5	1893	733	A. J. Krupy	F. V. Smith	Sargent & Lundy, 140 So. Dearborn St., Chicago, Ill.
Cincinnati	2	June 30, '20	180	M. S. Schneider	V. G. Rettig	Cincinnati Gas & Elec. Co., 327 Plum St., Cincinnati, Ohio
Cleveland	2	Sept. 27, '07	298	H. J. Dible	J. C. Strasbourger	Cleveland Elec. Ill. Co., 75 Public Square, Cleveland, Ohio
Columbus	2	Mar. 17, '22	95	F. W. Atkinson	N. J. Greene	National Electric Coil Co., Columbus, Ohio
Connecticut	1	Apr. 16, '21	265	R. S. Judd	A. G. Conrad	Yale University, New Haven, Conn.
Dallas	7	May 18, '28	140	C. W. Mier	H. R. Pearson	Dallas Power & Light Co., Engg. Dept., Dallas, Texas
Denver	6	May 18, '15	182	R. H. Owen	John R. Walker	U. S. Bureau of Reclamation, Denver, Colo.
East Tennessee	4	Sept. 2, '36	118	K. E. Hapgood	W. G. Parrott, Jr.	Tennessee Elec. Power Co., 417 Power Bldg., Chattanooga, Tenn.
Erie	2	Jan. 11, '18	65	F. H. Craton	W. D. Bearce	4121 Sassafras St., Erie, Pa.
Florida	4	Jan. 28, '31	73	J. C. Jones	Joseph Weil	University of Florida, Gainesville, Fla.
Fort Wayne	5	Aug. 14, '08	98	F. H. Fleischer	C. R. Atkinson	General Electric Co., 1635 Broadway, Fort Wayne, Ind
Georgia	4	Jan. 14, '04	104	J. O'D. Shepherd	J. M. Flanigen	Georgia Power Co., Atlanta, Ga.
Houston	7	Aug. 7, '28	139	T. M. Keiller	L. H. Matthes	Box 2870, Beaumont, Texas
Iowa	5	June 25, '29	67	H. W. Anderson	G. F. Corcoran	State University of Iowa, Elec. Engg. Dept., Iowa City, Iowa
Ithaca	1	Oct. 15, '02	51	True McLean	J. P. Wood	Cornell University, Ithaca, N. Y.
Kansas City	7	Apr. 14, '16	125	L. L. Davis	E. J. Karsten	P. O. Box 679, Kansas City, Mo.
Lehigh Valley	2	Apr. 16, '21	191	S. S. Seyfert	J. E. Treweek	Pennsylvania Power & Light Co., Hazleton, Pa.
Los Angeles	8	May 19, '08	483	M. A. Sawyer	F. C. Lindvall	California Institute of Technology, Pasadena, Calif.
Louisville	4	Oct. 15, '26	56	J. M. Houchens	J. F. Miller	Louisville Gas & Elec. Co., Louisville, Ky.
Lynn	1	Aug. 22, '11	145	C. F. Savage	J. W. Lingary	Lynn Gas & Electric Co., 788 Broad St., West Lynn, Mass.
Madison	5	Jan. 8, '09	65	W. A. Kuehlthau	H. J. Kubiak	University of Wisconsin, Elec. Lab., Madison, Wis.
Mansfield	2	Mar. 6, '39	64	H. F. Herbig	H. N. Diller	Ohio Public Service Co., Mansfield, Ohio
Maryland	2	Dec. 16, '04	224	H. A. Frey	G. R. Page	Western Electric Co., Point Breeze Works, Baltimore, Md.
Memphis	4	May 23, '30	61	G. F. Leake	A. H. Murrell	Memphis Power & Light Co., 178 Walnut St., Memphis, Tenn.
Mexico	3	June 29, '22	56	C. Santacruz	C. C. Jagou	Apartado 2966, Mexico City, Mexico
Michigan	5	Jan. 13, '11	358	W. G. Knickerbocker	E. V. Sayles	Commonwealth & Southern Corp., Jackson, Mich.
Milwaukee	5	Feb. 11, '10	270	L. T. Rosenberg	R. H. Earle	206 North 85th St., Wauwatosa, Wis.
Minnesota	5	Apr. 7, '02	89	I. B. Garthus	K. J. Mertz	Northern States Power Co., St. Paul, Minn.
Montana	9	June 24, '31	39	C. F. Bowman	W. A. Boyer	2921 Edwards St., Butte, Mont.
Muscle Shoals	4	Feb. 18, '38	46	W. M. Stanley	H. R. Nelson	Box 511, Guntersville Dam, Ala.
Nebraska	6	Jan. 21, '25	56	O. E. Edison	C. F. Holdrege	327 North 41st Ave., Omaha, Neb.
New Orleans	4	Dec. 8, '33	97	L. L. Newman	F. E. Johnson	317 Baronne St., New Orleans, La.
New York	3	Dec. 10, '19	3,355	George Sutherland	D. A. Quarles	Bell Telephone Labs., Inc., 463 West St., New York, N. Y.
Niagara Frontier	1	Feb. 10, '25	201	G. M. Pollard	J. H. Milbyer	Buffalo Niagara Elec. Corp., 300 Electric Bldg., Buffalo, N. Y.
North Carolina	4	Mar. 21, '29	85	R. S. Fouraker	V. R. Parrack	Carolina Power & Light Co., Raleigh, N. C.
Oklahoma City	7	Feb. 16, '22	120	C. E. Bathe	John Shawver	Oklahoma Gas & Electric Co., Oklahoma City, Okla.
Philadelphia	2	Feb. 18, '03	610	E. P. Yerkes	W. B. Morton	Philadelphia Electric Co., Edison Bldg., Philadelphia, Pa.
Pittsburgh	2	Oct. 13, '02	517	E. W. Oesterreich	G. R. Patterson	Carnegie Institute of Technology, Pittsburgh, Pa.
Pittsfield	1	Mar. 25, '04	178	C. A. Read	M. E. Scoville	General Electric Co., Pittsfield, Mass.
Portland	9	May 18, '09	151	Corbett McLean	J. A. Hooper	Northwestern Elec. Co., Public Service Bldg., Portland, Ore.
Providence	1	Mar. 12, '20	91	W. B. Hall	O. E. Sawyer	56 Friendly Road, Auburn, R. I.
Rochester	1	Oct. 9, '14	95	C. E. Tuites	W. F. Cotter	Stromberg-Carlson Tel. Mfg. Co., Rochester, N. Y.
St. Louis	7	Jan. 14, '03	268	R. S. Glasgow	R. H. Baxter	Southwestern Bell Tel. Co., 1330 Telephone Bldg., St. Louis, Mo.
San Antonio	7	May 23, '30	43	Bro. L. P. Thein	Eugene Bissett	San Antonio Public Service Co., Box 1771, San Antonio, Texas
San Diego	8	Jan. 18, '39	30	F. F. Evenson	C. J. Nevitt	San Diego Consolidated Gas & Elec. Co., San Diego, Calif.
San Francisco	8	Dec. 23, '04	486	C. A. Andrews	M. S. Barnes	General Electric Co., 804 Russ Bldg., San Francisco, Calif.
Saskatchewan	10	Oct. 14, '25	21	P. E. Kirkpatrick	M. L. Haynes	Balfour Technical School, Regina, Sask., Canada
Schenectady	1	Jan. 26, '03	403	C. W. LaPierre	O. C. Rutledge	General Electric Co., Works Lab., Schenectady, N. Y.
Seattle	9	Jan. 19, '04	153	C. J. Hawkes	A. I. Launder	Pacific Tel. & Tel. Co., 1200—3rd Ave., Seattle, Wash.
Sharon	2	Dec. 11, '25	86	E. Steinert	C. L. Knotts	Westinghouse Elec. & Mfg. Co., Sharon, Pa.
Spokane	9	Feb. 14, '13	62	Neal Eaden	G. L. Lane	Washington Water Power Co., 825 Trent Ave., Spokane, Wash.
Springfield	1	June 29, '22	60	R. E. Curtis	H. D. Griffith	Westinghouse Elec. & Mfg. Co., Springfield, Mass.
Syracuse	1	Aug. 12, '20	71	C. W. Henderson	E. A. Gruppe	523 E. Genesee St., Fayetteville, N. Y.
Toledo	2	June 3, '07	78	J. S. Sawvel	W. M. Campbell	Toledo Edison Co., Toledo, Ohio
Toronto	10	Sept. 30, '03	338	D. G. Geiger	F. C. Barnes	Canadian General Electric Co., Ltd., 212 King St., W., Toronto
Tulsa	7	Oct. 1, '37	107	A. L. Jones	H. P. Dougherty	Southwestern Bell Telephone Co., Tulsa, Okla.
Urbana	5	Nov. 25, '02	77	G. H. Fett	C. A. Schille	Illinois Iowa Power Co., Champaign, Ill.
Utah	9	Mar. 9, '17	76	F. E. Young, Jr.	A. C. Kelm	Utah Power & Light Co., Salt Lake City, Utah
Vancouver	10	Aug. 22, '11	107	G. K. Haspel	T.F. Hadwin	B. C. Electric Railway Co. Ltd., Vancouver, B. C., Canada
Virginia	4	May 19, '22	94	F. W. Smith	L. Saunders	1042 Jamestown Crescent, Norfolk, Va.
Washington	2	Apr. 9, '03	332	R. W. Prince	F. B. Crider	806—15th St., N. W., Washington, D. C.
Wichita	7	Sept. 16, '37	46	W. J. Knightley	R. B. Gow	Kansas Gas & Electric Co., Wichita, Kansas
Worcester	1	Feb. 18, '20	58	R. H. Bryant	W. W. Locke	Worcester Polytechnic Institute, Worcester, Mass.
Total	67					